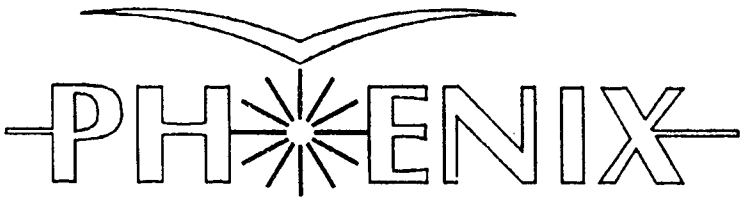
RHIC/PHENIX DETECTOR



Muon Magnet South-Preliminary Design Review

LLNL: Joel M. Bowers, Anthony S. Ladran, Arthur S. Posey, James H. Thomas, Thomas M. Vercelli, Robert M. Yamamoto

RIKEN/MELCO: Shintaro Fukumoto, Takashi Ichihara, Naohito Saito

BNL: Peter J. Kroon, Thomas Shea

Representing the BNL, RIKEN/MELCO and LLNL Design Team

May 1, 1996

Muon Magnet South - Preliminary Design Review
Meeting Notes and Action Items

Tom Vercelli
May 1, 1996

Participants:
LLNL - Bob Yamamoto, Tom Vercelli, Jim Thomas, Art Posey, Tony Ladran, Joel Bowers
RIKEN/MELCO - Takashi Ichihara, Shintaro Fukumoto, Naohito Saito
BNL - Pete Kroon, Tom Shea
LANL - No participants

The preliminary design review was conducted on May 1, 1996 via a video conference between BNL and LLNL. Presentation on the MMS steel fabrication was given by Shintaro Fukumoto of RIKEN/MELCO, Japan, the MMS track system and seismic restraint systems were presented by Tom Vercelli and Art Posey of LLNL, and MMS coils by Bob Yamamoto of LLNL. Integration and rigging issues were addressed by Pete Kroon of BNL. A summary of the review with action items follows.

Note: Prior to the PDR, a day of discussions between LLNL and RIKEN/MELCO were held at LLNL. Detail design and assembly issues were discussed, as well as task responsibilities. RIKEN/MELCO will provide a static structural analysis, an assembly sequence plan, and a dimensional inspection plan at the final design review. LLNL will provide to RIKEN/MELCO an analysis of the back plate to base plate bolted connection. Bolt size and quantity will be determined and the information given to RIKEN/MELCO prior to the final design review.
Bob Yamamoto discussed MMS coil items with RIKEN/MELCO.
Jim Thomas discussed Budget and schedule items with RIKEN/MELCO.

Muon Magnet South - Steel Fabrication Design - Shintaro Fukumoto

The magnet steel design for the south muon magnet is being done using the conceptual design drawings of MMS along with the detailed drawings of MMN both supplied by LLNL. Shintaro started by giving an overview of using Pro-E and CAD data exchange systems. He then gave a brief explanation of MMS design components and their weights. In describing the piston core, discussions of assembling the coils to the piston before or after the piston is mounted to the back plate took place. It was decided to assemble the coils to the piston after the piston is mounted to the back plate.

Action Item - RIKEN/MELCO is to assemble the piston coils to the piston <u>after</u> the piston is mounted to the back plate.

The lower lampshade gussets are to be made of 304L stainless steel. This design feature is listed on MMN drawings. During lampshade discussions Joel Bowers explained to me that after assembling the lampshade panels and all dimensions are checked and verified, small tabs are welded onto the back plate just under the surface of each lampshade panel. These tabs act as locating devices to insure proper panel position when panels are removed and then replaced. The pin design is indicated on the MMN Russian drawings only. We need to get this information to RIKEN/MELCO.

Action Item - Art Posey is to get pin design and locations to RIKEN/MELCO before magnet assembly.
Art Posey will check that the lampshade gussets, and fins are stainless steel.

MMS assembly sequence was shown along with connection details. The lower lampshade panels along with the side boxes will be bolted from the back side of the back plate. The bolts will be installed through the back plate into tapped holes in the panels and boxes. Joel Bowers explained to me that the counter bore for the MMN piston location in the back plate is one inch deep and nine or ten inches in diameter. This is only noted on the Russian MMN drawings. This information needs to get to RIKEN/MELCO. This topic was discussed in the PDR preliminary discussions on 4/30/96.

Action Item - Tom Vercelli and Art Posey are to investigate this design feature and update LLNL MMN drawings. This information must be given to RIKEN/MELCO as soon as possible.

RIKEN/MELCO would like to use a primer called "Rustite". BNL must investigate compatibility of rustite with the top coat to be use on MMS. BNL is responsible for painting of MMS.

Action Item - BNL must determine what paint is to be used on MMS and its compatibility with the primer RIKEN/MELCO will use. Color must also be determined.

Muon Magnet South Coils - Bob Yamamoto and Shintaro Fukumoto

Shintaro began by explaining pre-preg construction versus vacuum impregnation. RIKEN/MELCO will use pre-preg construction. Fabrication techniques were explained and coil specifications reviewed. A design change by RIKEN/MELCO involving the number of turns was discussed. The bottom coil needs to be longer to get leads in and out. Bob Yamamoto requested RIKEN/MELCO to look at other options so that the 2 coil halves (top and bottom) are identical in the number of turns they have.

Action Item - Shintaro Fukumoto is to report back to Bob Yamamoto with other design options before finalizing which design to use.

Shintaro then presented the factory test and inspection specifications along with a timeline schedule.

MMS Track System and Seismic Restraints - Tom Vercelli and Art Posey

The areas presented by Tom Vercelli and Art Posey were, track system, seismic restraints, hydraulic components, and back plate/base plate connection. The track system incorporates anchor plates for the vertical restraint rods. Pete Kroon indicated that the plates cover survey monuments in the floor. Clearance holes will be added to the plates.

Action Item - Art Posey is to make a design change to anchor plates. Holes will be added in the plates where the survey monuments are located. Locations to be verified by Pete Kroon.

It was also noted that the south track extensions protrude into the detector region at the ID plates. Tom Shea noted that protrusion beyond 6800mm should not occur. In looking at the drawings the roller stop on the tracks protrudes past the 6800mm limit.

Action Item - Tom Vercelli and Art Posey are to resolve this problem. A few options exist and will be explored by Tom and Art. Consultation with Marcus Libkind and Ken Read on ID plate flatness should be done. Some seem to think the ID plates are flatter than expected.

Nao thinks the ID panel is at 6950mm from vertex. This requires 20cm stay clear zone.

Regarding cylinder design, Pete was under the impression that all four cylinders were the same. Art indicated that one of the MMS cylinders has a different clevis attachment on one end. Pete indicated that the cylinder order, for four each, was being placed.

Action Item - Pete Kroon is to stop placement of cylinder order until receiving latest information from Art on MMS cylinder design.
Art Posey is to get the MMS cylinder detail to Rich Ruggerio/Pete Kroon as soon as possible.

The back plate to base plate connection was discussed. All parties agree that this shall be a rigid connection using bolts passing through the base plate into tapped holes in the back plate bottom edge. The bolt size will be determined based on using 14 bolts per back plate section for a total of 42 bolts. LLNL is to provide RIKEN/MELCO with the bolt size.

Action Item - Tom Vercelli/ Tony Ladran to perform FEA analysis to size the bolts and give information to RIKEN/MELCO.

Closing discussions centered around having the final design review at Santa Fe in July 1996. All were in agreement that this would be the correct thing to do. Most interested parties will be in Santa Fe for the Collaboration Meeting in July.

BNL needs to have the tracks or temporary tracks in the assembly hall by April 1997.

LLNL is to acquire lead for the counter weight.

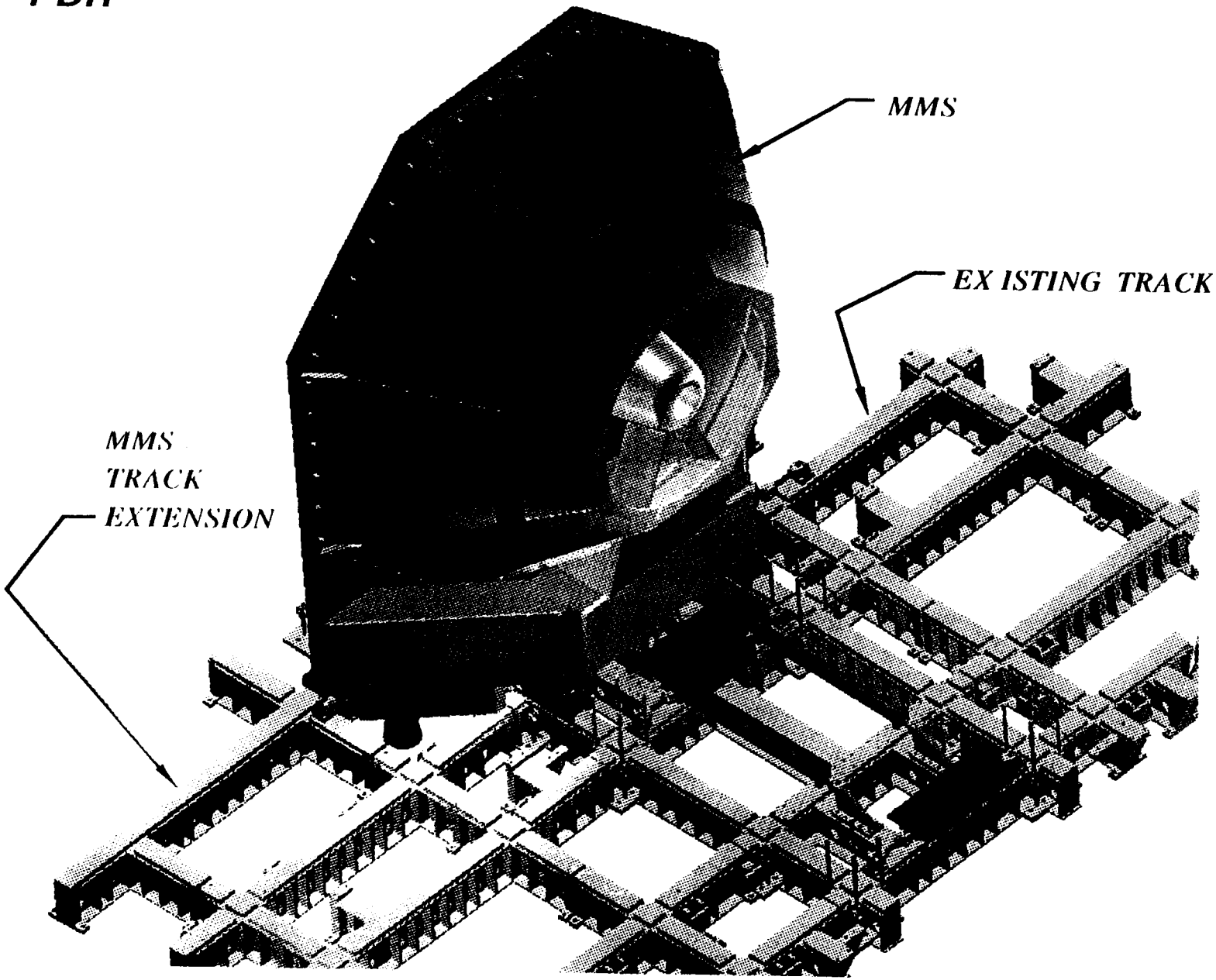
PDR Discussion Notes on 4/30/96
Tom Vercelli

- Briefed RIKEN/MELCO on topics Tom, Art, and Tony will present at PDR on 5/1/96.
- The back plate to base plate bolted connection was discussed. A few quick calculations of the bolt loading were done on the ink board. Shin has only considered tensile load. LLNL (Tony) will look at combined loading of tensile, shear, and bending at this interface. von Mises stress should be calculated. This will not be discussed in detail at the PDR. It will be mentioned as a design issue currently being worked.
- Jim Thomas has asked RIKEN/MELCO provide analysis on the stability of the back plate to base plate connection to side boxes. RIKEN/MELCO has agreed to provide this information. If cribbing, or some other assembly stabilizing method is required, or is planned by RIKEN/MELCO, this information shall be provided at the FDR.
- RIKEN/MELCO asked if it is possible to provide a gusset or column support between the lampshade panel and side box. We stated this would be OK as long as it did not break the plane of the outer side of the box. This could cause interference with the detector carriages.
- We would like to know what BNL is planning on for MMS assembly at BNL regarding track system availability in the assembly hall. How is BNL going to assemble and install MMS if the track system is not ready? We have asked RIKEN/MELCO to ask BNL this to keep the pressure on BNL.
- RIKEN/MELCO will provide the dimensional inspection plan at the FDR.
- Do we (LLNL) required steel certification? If so, when and how will this information be supplied. (We can request the same as MMN.)
- RIKEN/MELCO does not have any design changes from LLNL's proposed design.
- RIKEN/MELCO will provide an assembly sequence/plan at the FDR.
- Shin now believes MELCO requires the additional time prior to the FDR to complete the design effort for the FDR. Takashi and Nao would prefer to hold the FDR at the Collaboration meeting in Santa Fe in July. It was agreed to have the FDR in Santa Fe. A video conference will be set up for the end of May to discuss any remaining design issues prior to RIKEN/MELCO steel order placement.
- I had a question on the counter bore in the back plate shown in the RIKEN/MELCO PDR packet for the piston. The c'bore is shown to be at a diameter of the outer diameter of the coil. This is incorrect and should be at the outer piston diameter. Shin agreed and explained that they are machining 6 mm off the surface for cleanup to provide a flat mounting surface for the piston, along with clearance for the coil. Plate surface deviation is 6 mm. The c'bore will be a double step with the piston locating c'bore 2 mm deeper than the 6mm c'bore for clean up.

Is it necessary to clean up the surface for coil placement? What is the axial location accuracy required on coil placement? The double c'bore may not be necessary.

PHENIX – MUON MAGNET SOUTH
PDR

5–1–96



RHIC/PHENIX DETECTOR SYSTEM

Muon Magnet South

Fabrication Design of MMS

Preliminary Design Review

Shintaro Fukumoto

Mitsubishi Electric Corporation

KOBE WORKS

May 1, 1996

at LLNL

Contents of this talk

1. Fabrication design
   - 3D CAD (Pro/ENGINEER(TM))
   - CAD data exchange
   - Muon Magnet South assembly
   - Component weights
2. Steel design
   - Component design feature
   - Assembly flow
   - Connection details
   - Surface preparation (Steel)
3. Coil design
   - Insulation method
   - Insulation system
   - Winding
   - Surface preparation (Coil)
   - Coil parameters
4. Factory test and inspection
5. MMS manufacturing schedule
6. Drawings

Fabrication design

- Basic design was done by Lawrence Livermore National Laboratory (LLNL).
- The above results was presented by means of 3D CAD (Pro/ENGINEER(TM)) data.
- It will be based on structural design of MMN.

3D CAD (Pro/ENGINEER(TM))

Merit of using Pro/E

- Design can be consistently updated through the project.
  - Unique database throughout modeling, drawing and manufacturing (Now CAM function is not available at Mitsubishi)
  - Full associativity between 2D and 3D files

CAD data exchange

- Pro/E data can not directly be downloaded from LLNL to Mitsubishi by ftp because of our network security.
- Data exchange between LLNL and RIKEN/Mitsubishi is as follows,

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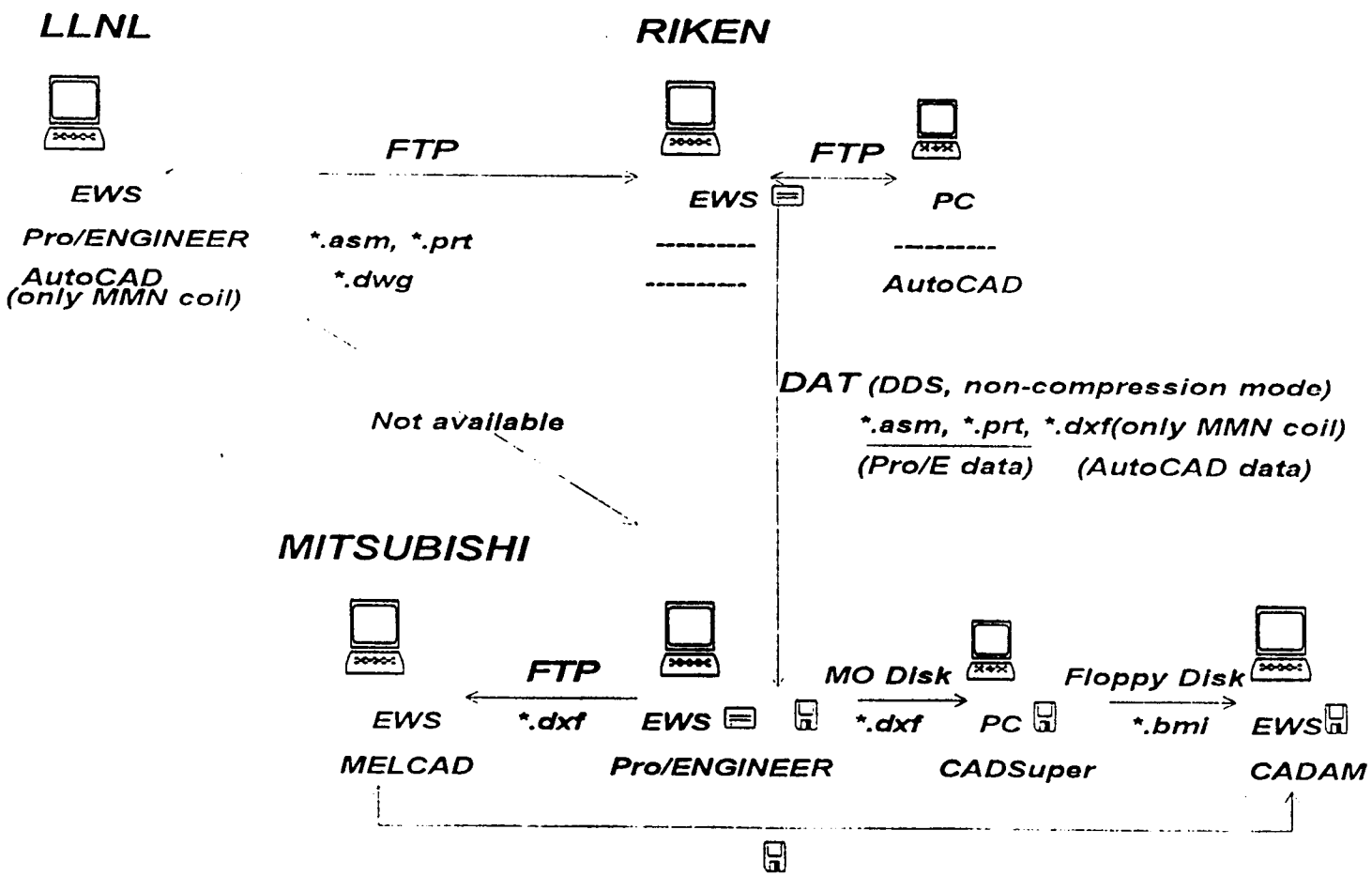
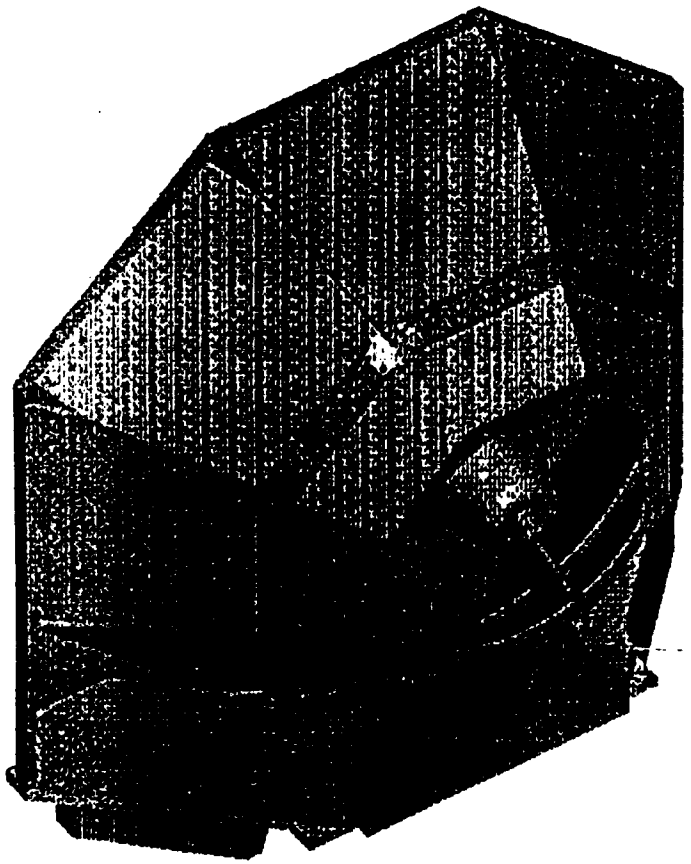
CAD data exchange

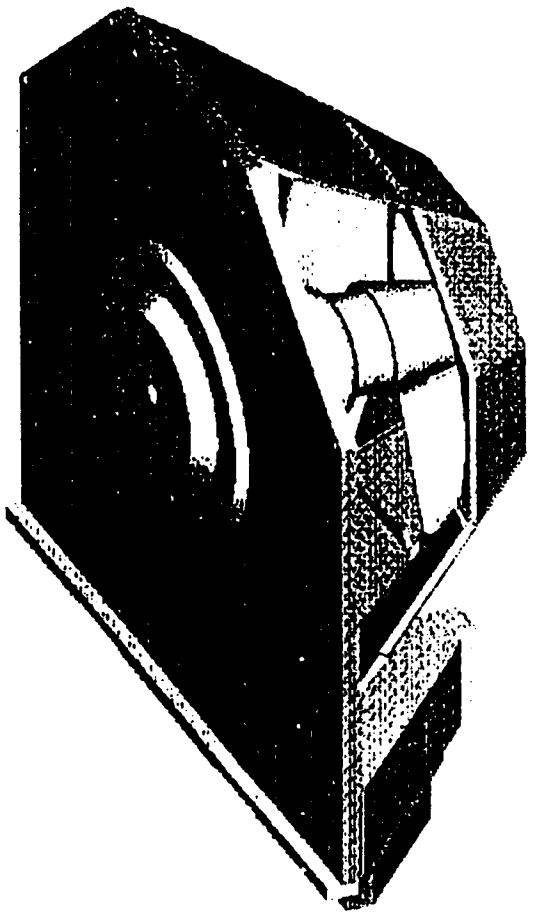


MITSUBISHI ELECTRIC CORPORATION

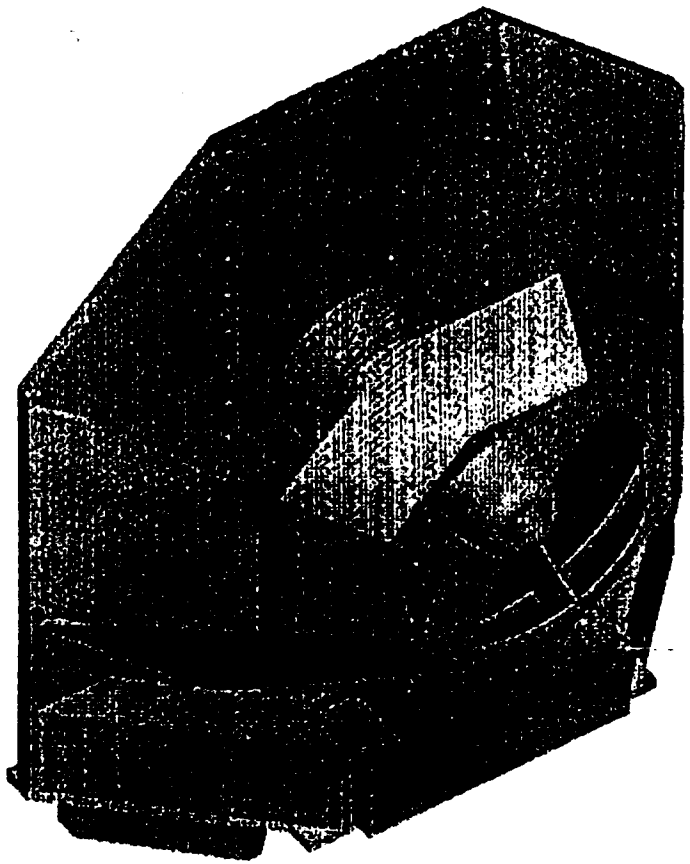
Muon Magnet South assembly



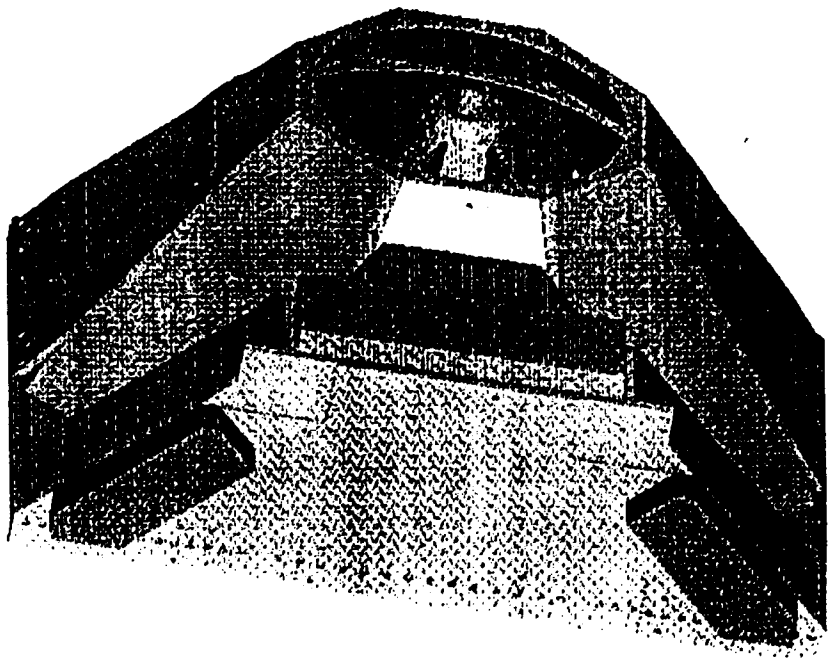
Muon Magnet South assembly



Muon Magnet South assembly



Muon Magnet South assembly



Component weights

Item	Quantity	Unit weight	Total weight
Back-plate(mid)	1	33,300	33,300
Back-plate(side)	2	22,700	45,400
Donut(big)	1	6,238	6,238
Donut(small)	1	4,701	4,701
Lower-plate	1	15,964	15,964
Side block	2	3,656	7,312
Mid block	1	5,500	5,500
Lead	1	~~100,000~~ 44	~~100,000~~ 44
Piston	1	30,982	30,982
Lampshade panel(top)	5	3,541	17,705
Lampshade panel(bottom)	1	14,835	14,835
Teacup	1	6,091	6,091
Others (side weight and so on)	1	13,764	13,764
Coil(front)	1	554	554
Coil(rear)	1	1,281	1,281
		Total weight:	~~363~~ 247,627 kg

side 13 × 2 } 49 US ton
mid 23 }
≈ 44 metric ton

MITSUBISHI ELECTRIC CORPORATION

Steel design

- Component design feature
- Assembly flow
- Connection details
- Surface preparation (steel)

Component design feature 1)

Piston core

- Made of forged low carbon steel (AISI 1006 equivalent)
  - to avoid magnetic saturation
- Mounted on the backplate, ~~after~~ before assembling with the muon magnet coils
- Additionally supported by stainless steel (JIS SUS310) fins from bottom lampshade panel.

Component design feature 2)

■ Back-plate

- Consists of 3 plates made of low carbon steel (AISI1006 equivalent) plates
  - Flatness of the plate is less than 6mm
  - Each plate has no weld and no machining on the surface
- Weight of each plate is not exceed 40 US tons, BNL crane capacity.

Component design feature 3)

Lampshade panel

- Consist of 8 plates made of low carbon steel (AISI 1006 equivalent)
  - Flatness of the plate is less than 6mm
  - Each plate has no machining on the surface
- Panels are not joined together and leave a small space
- Top 5 panels are attached between the teacup assembly and the backplate and removable
  - not only to allow easy assembly and maintenance access, but also to have uniform magnetic field

Component design feature 4)

Teacup

- Made of low carbon steel (AISI1006 equivalent) and stainless steel (the mating flanges between the teacup and the bottom lampshade panels)
- Provide easy assembly and disassembly.
- Bolted to the bottom lampshade panels.

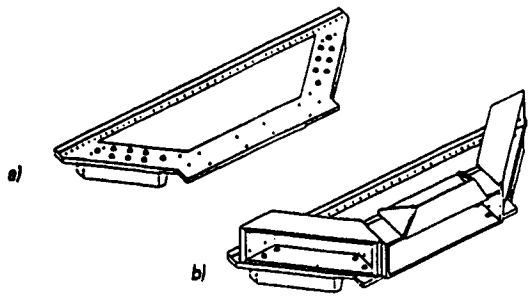
Component design feature 5)

- **Big and small donut**
  - Made of low carbon steel (AISI 1006 equivalent) plates
    - to relieve saturation in the backplate
  - Bolted to the back plate
- **Counter weight**
  - Consists of 3 blocks stuffed with lead bricks
  - Keep the center of gravity low and make sure of stability

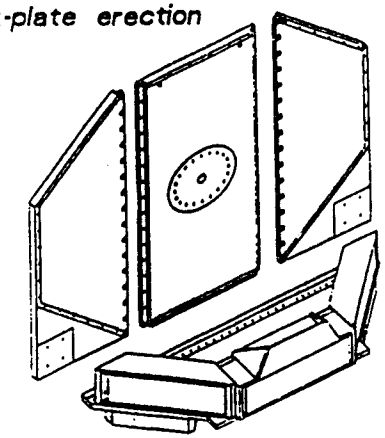
Assembly flow

- 1) Lower-plate installation
- 2) Back-plate erection
- 3) Bottom lampshade mount
- 4) Piston and fin added
- 5) Teacup and top lampshade added
- 6) Complete MMS system

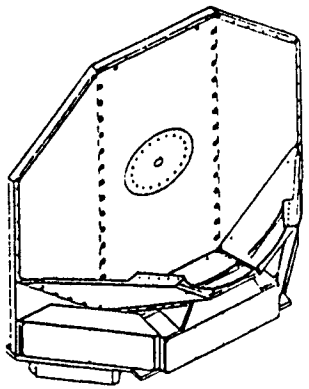
1) Lower-plate installation



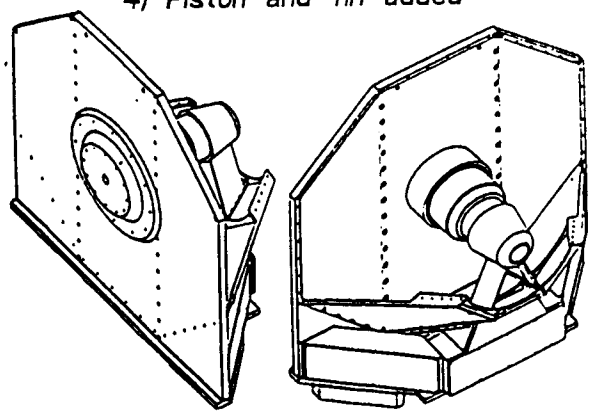
2) Back-plate erection



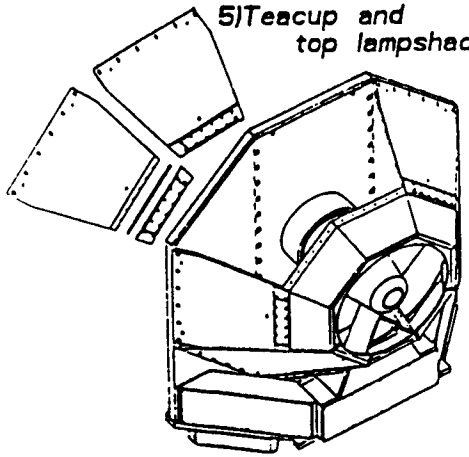
3) Bottom lampshade mount



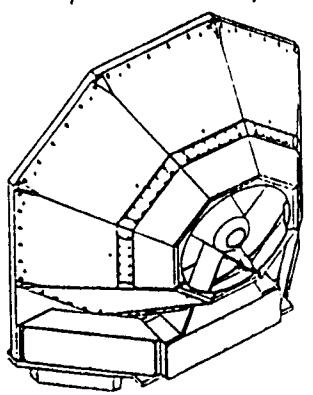
4) Piston and fin added



5)Teacup and top lampshade added



6) Complete MMS system

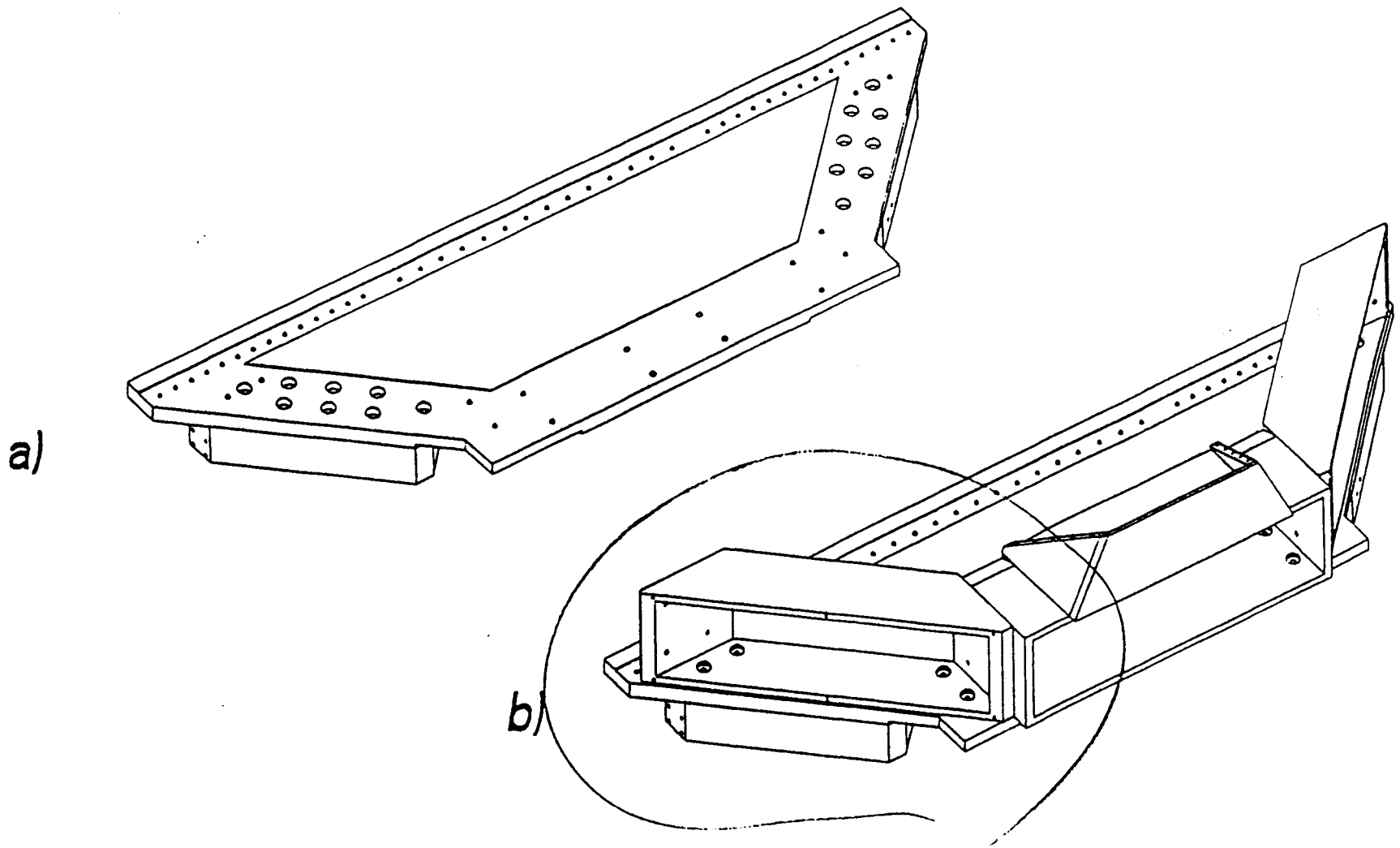


Assembly flow

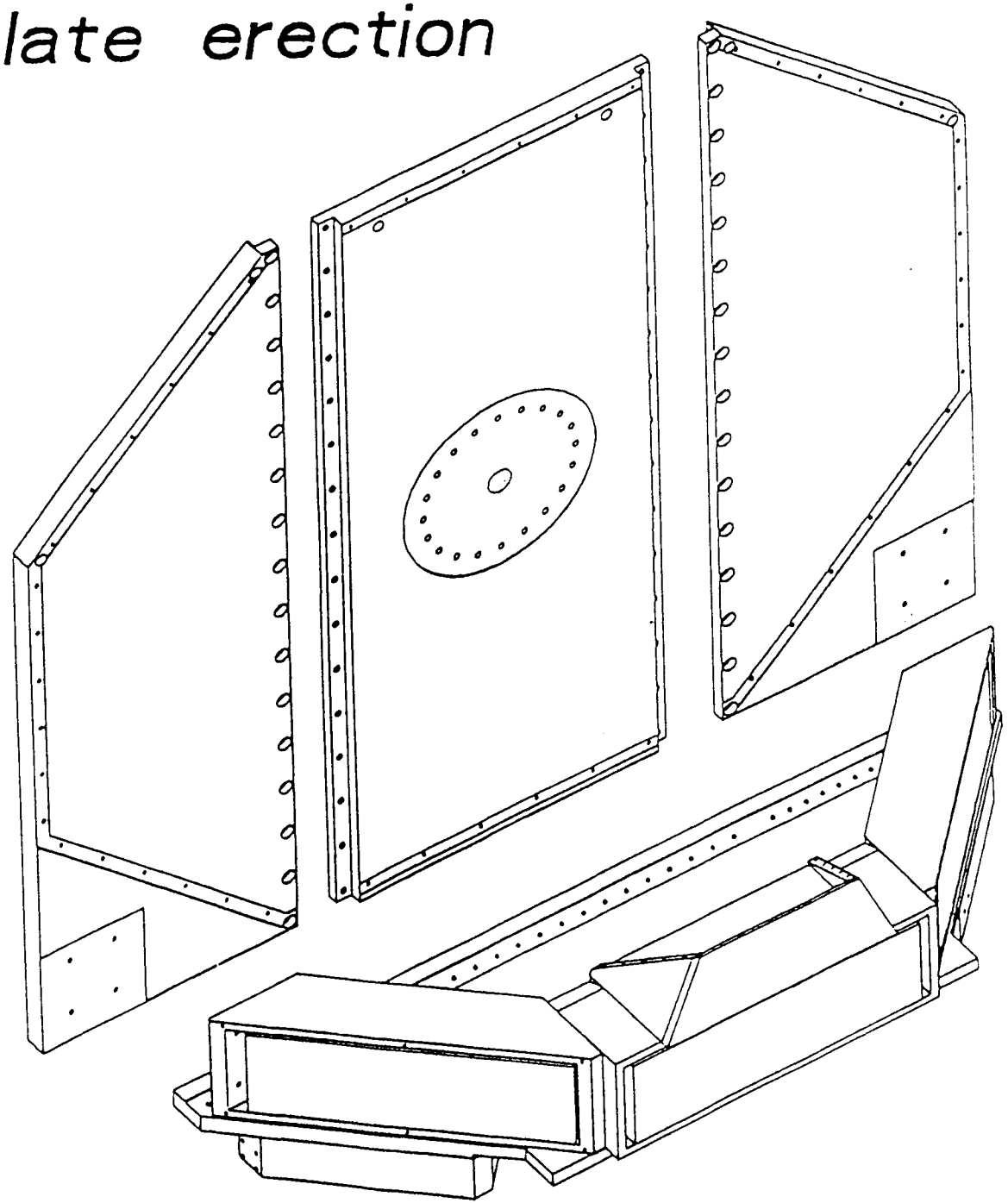
25-Apr-96

ASM_PROCESS

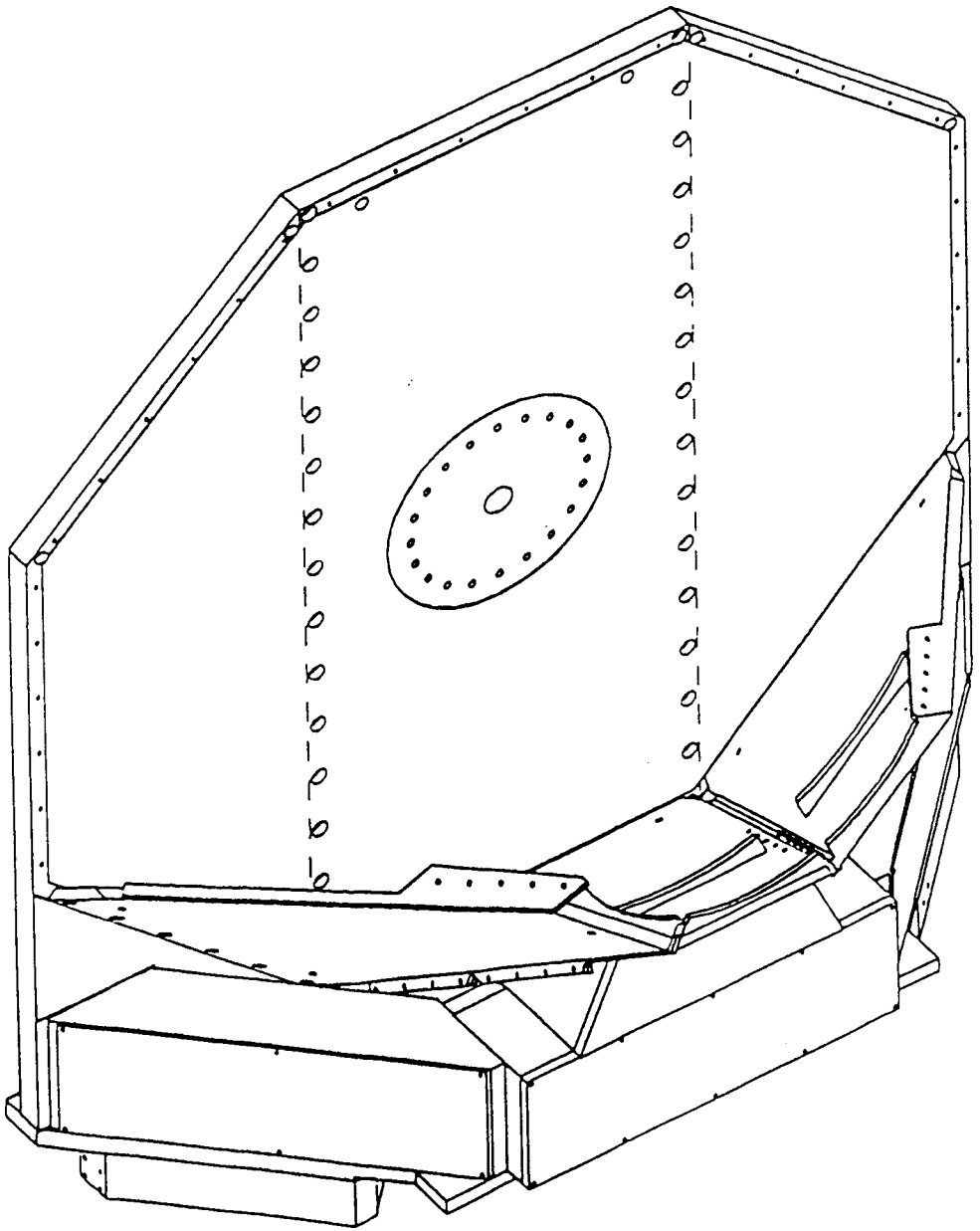
1) Lower-plate installation



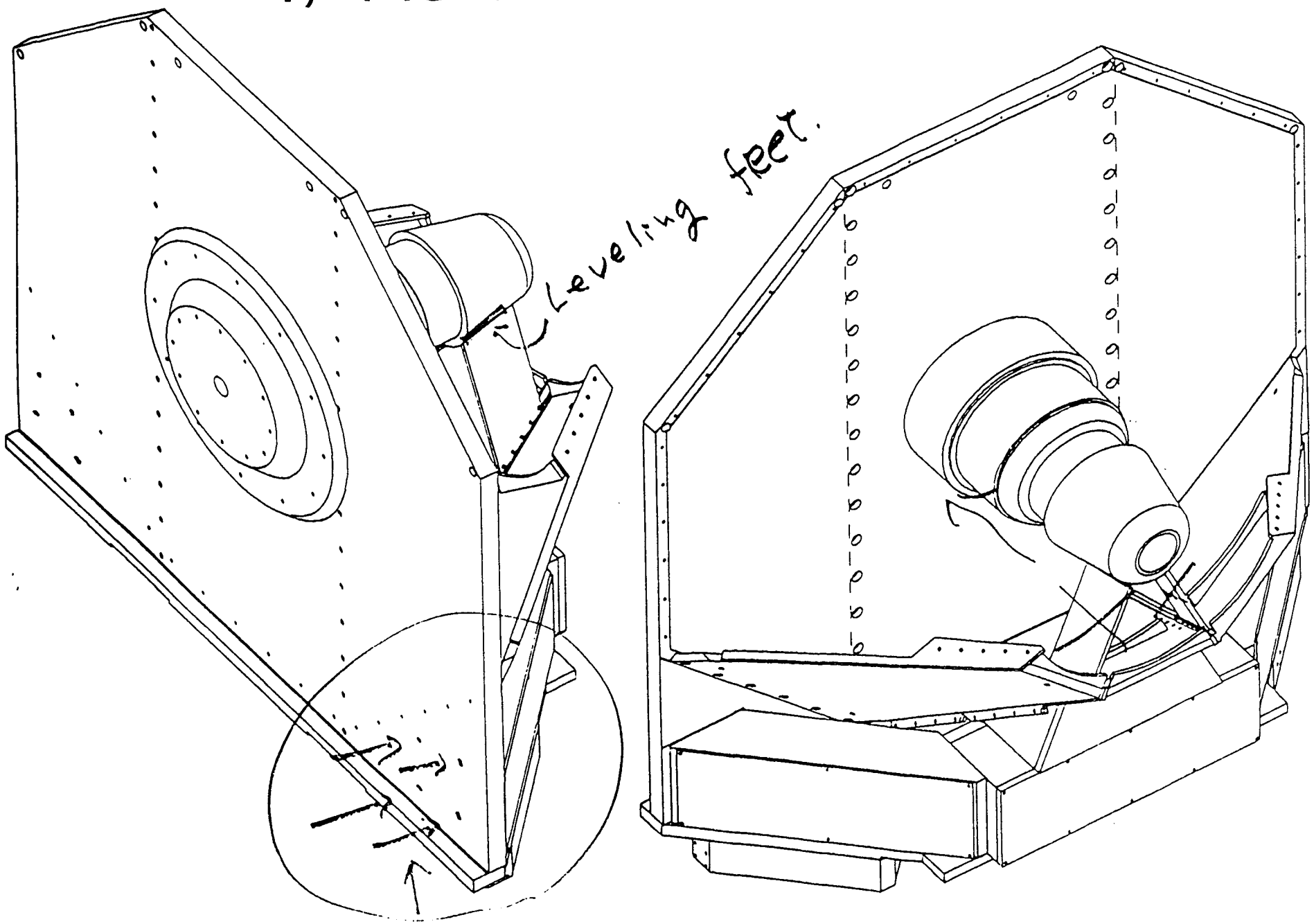
2) Back-plate erection



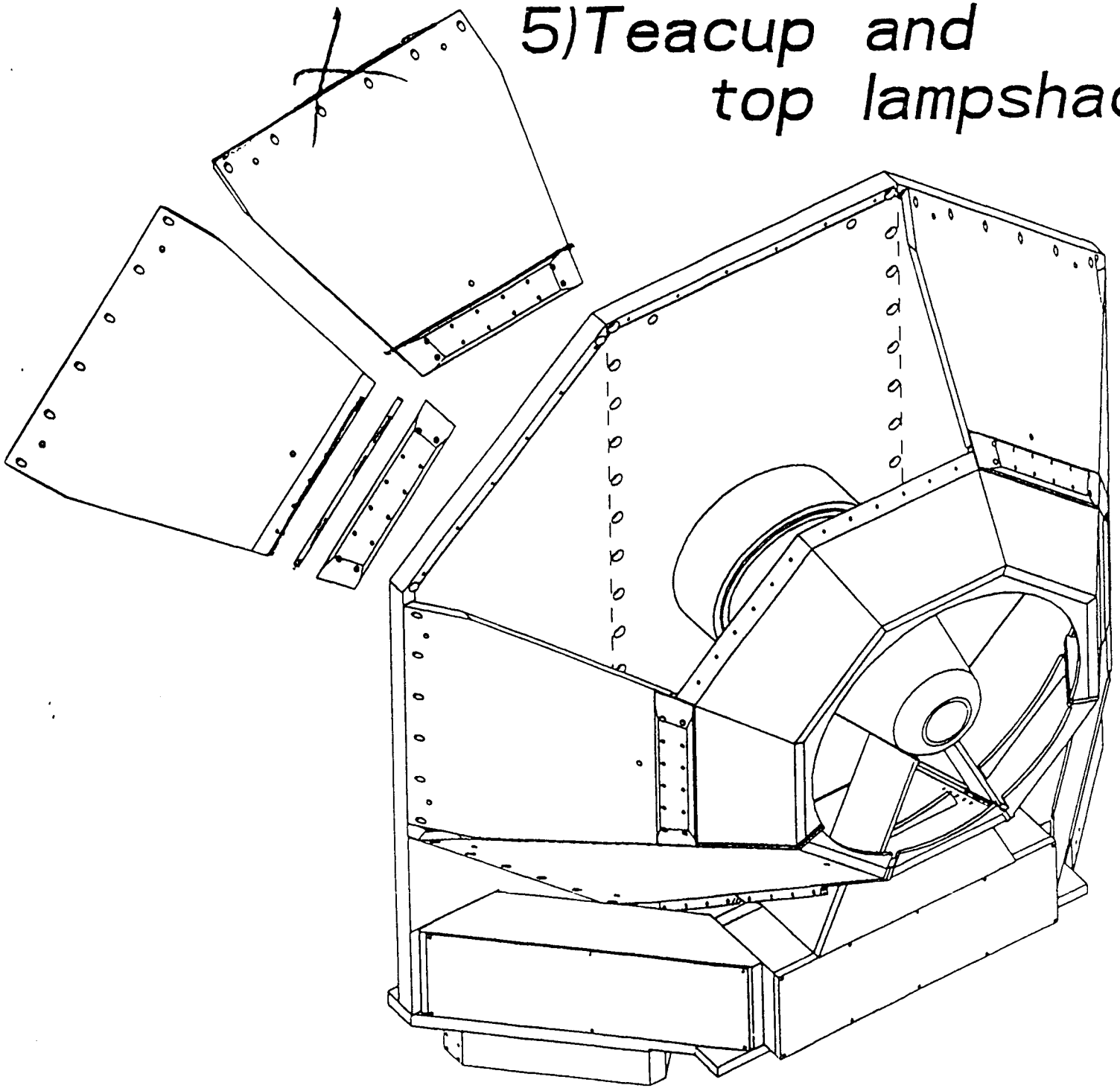
3) Bottom lampshade mount



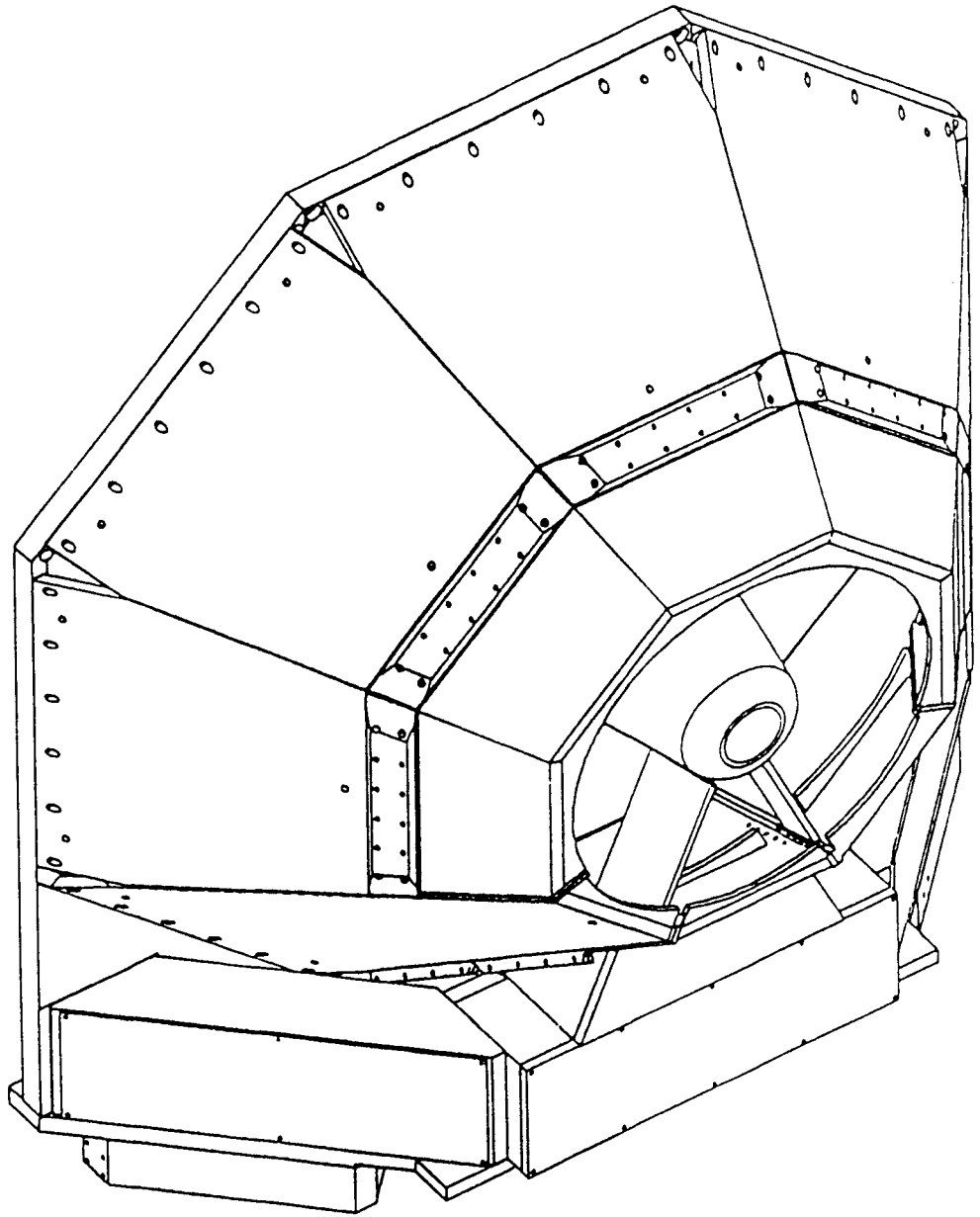
4) Piston and fin added



5) Teacup and top lampshade added



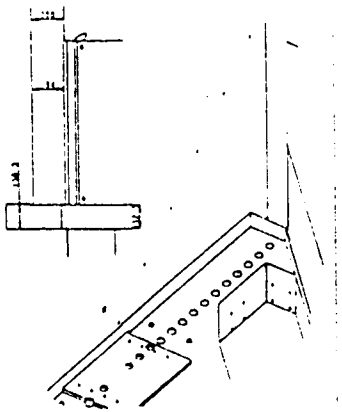
6) Complete MMS system



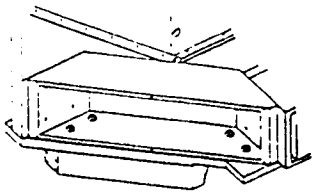
Connection details

- *Lowerplate -Backplate*
- *Backplate-Mid and side block*
- *Lampshade-Lampshade*
- *Lampshade-Backplate*
- *Lampshade-Gusset plate*
- *Lampshade-Fin support*
- *Lampshade-Teacup*
- *Lampshade-Splice bar and spacer bar*
- *Piston-Fin*
- *Piston-Backplate*
- *Donuts-Backplate*

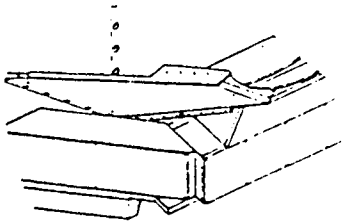
1 Lowerplate-Backplate



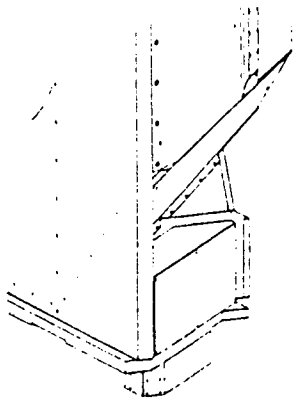
2 Backplate-Mid and side block



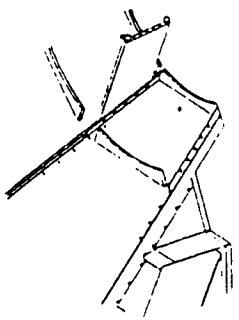
3 Lampshade-Lampshade



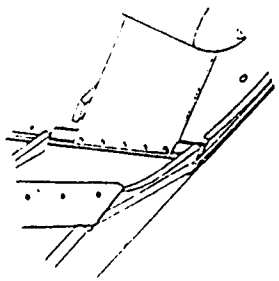
4 Lampshade-Backplate



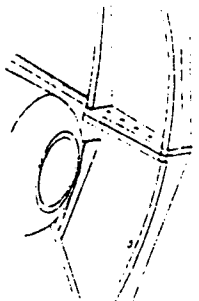
5 Lampshade-Gusset plate



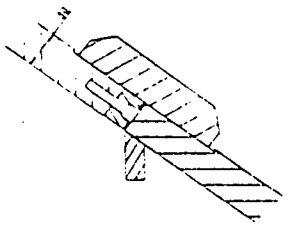
6 Lampshade-Fin support



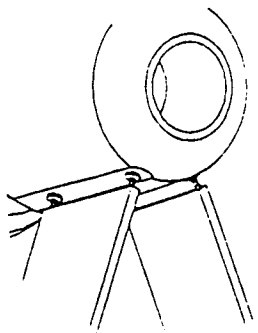
7 Lampshade-Teacup



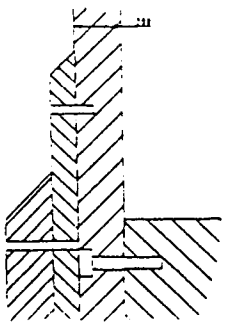
8 Lampshade-splice bar
spacer bar



9 Piston-Fin



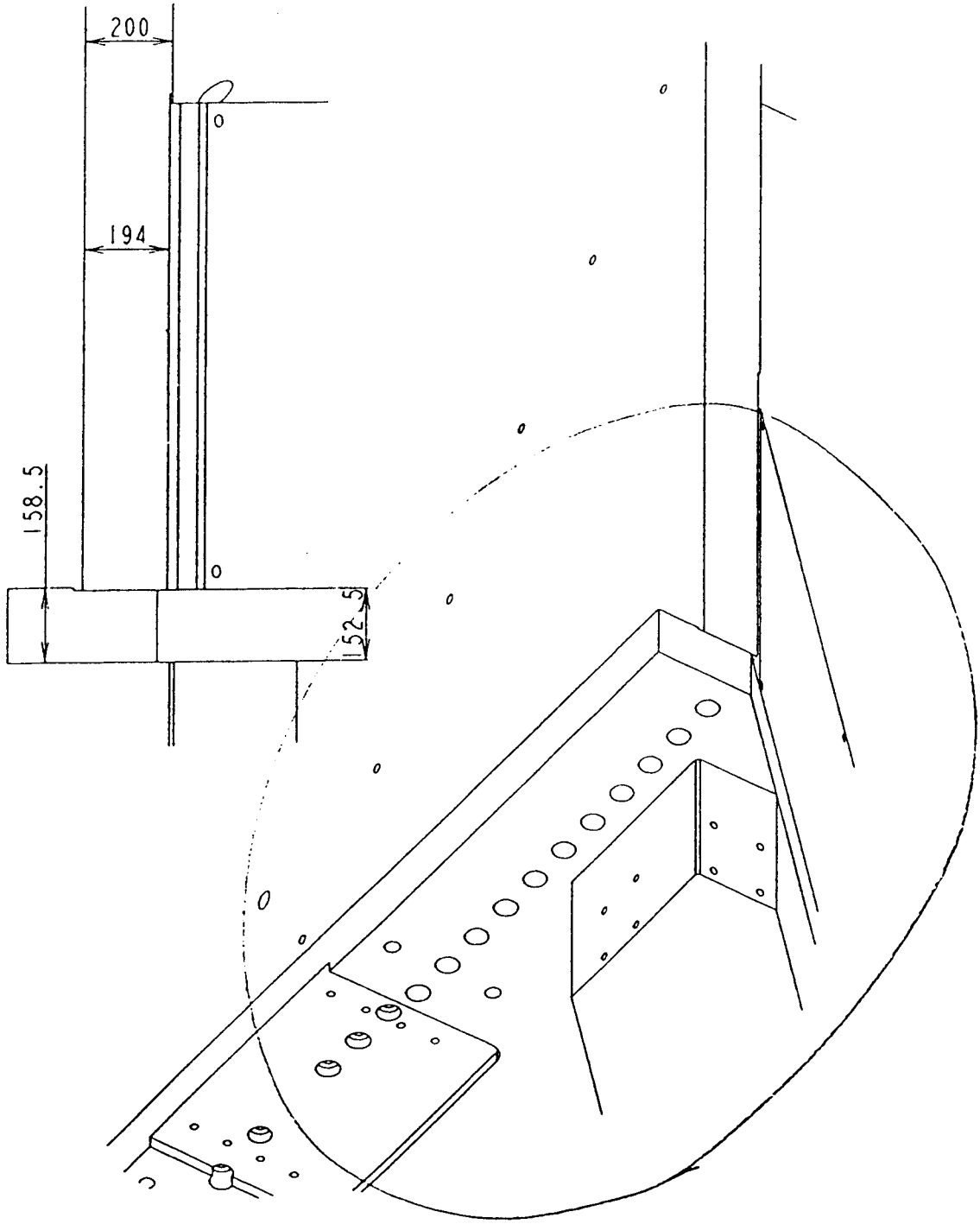
10 Piston-Backplate



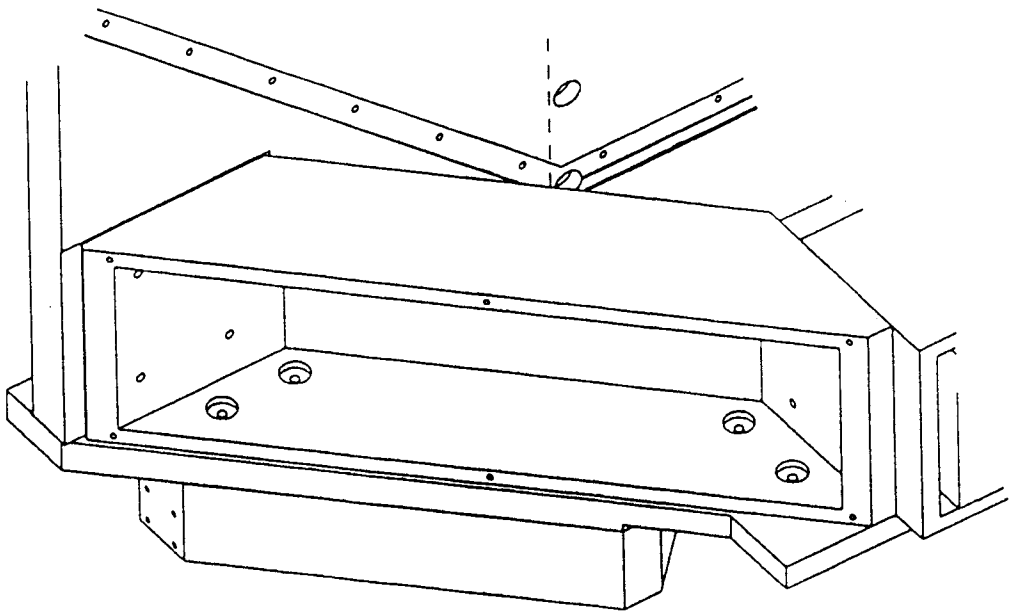
Connection detail

24-Apr-96

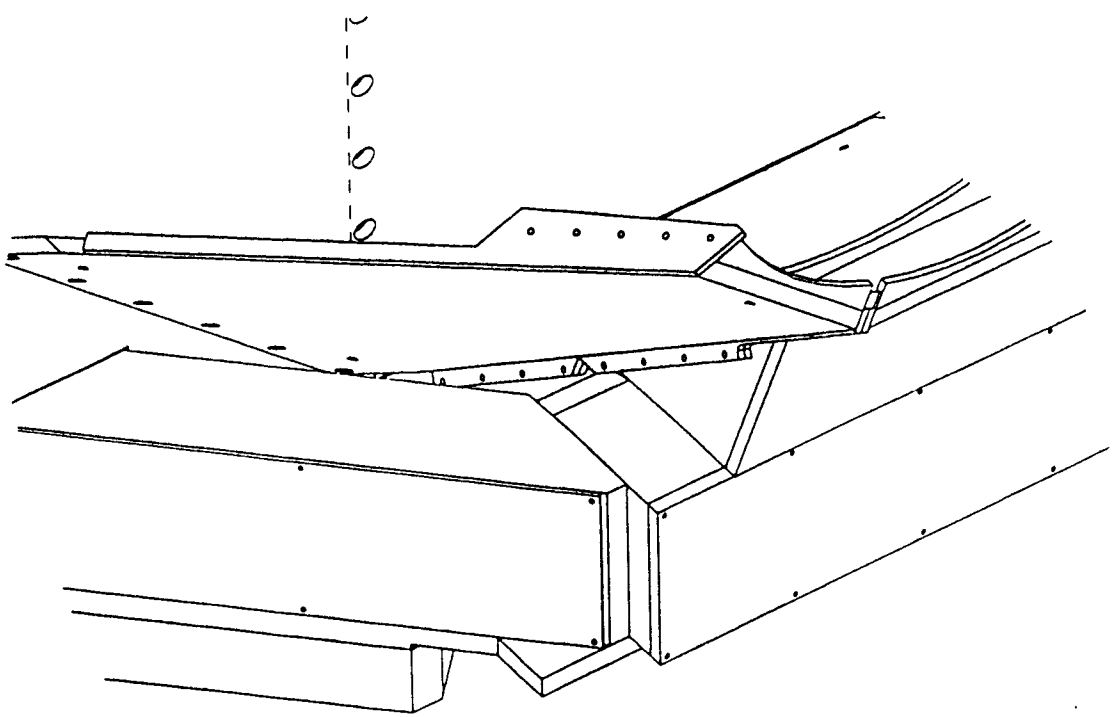
1.Lowerplate-Backplate



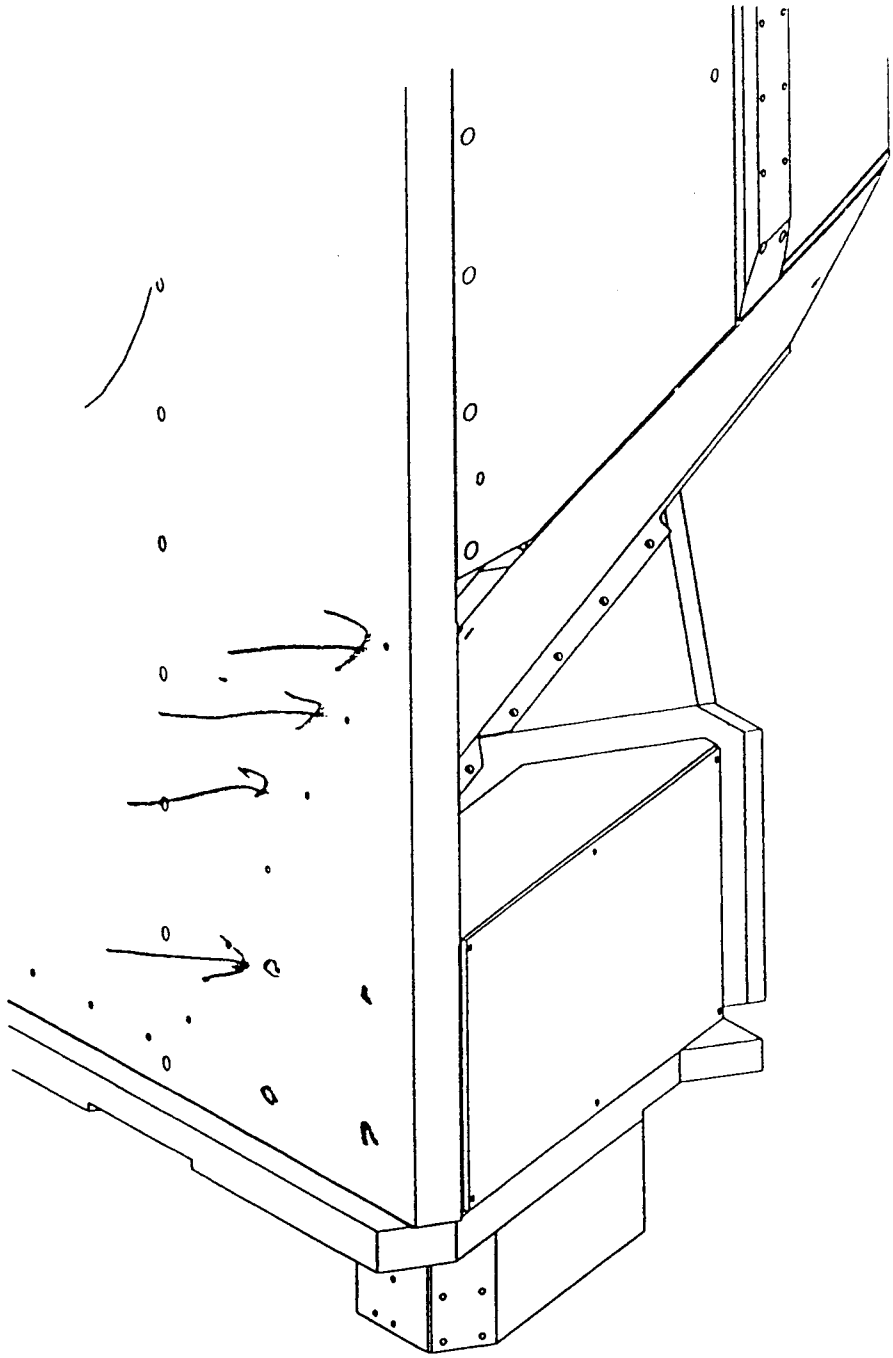
2.Backplate-Mid and side block



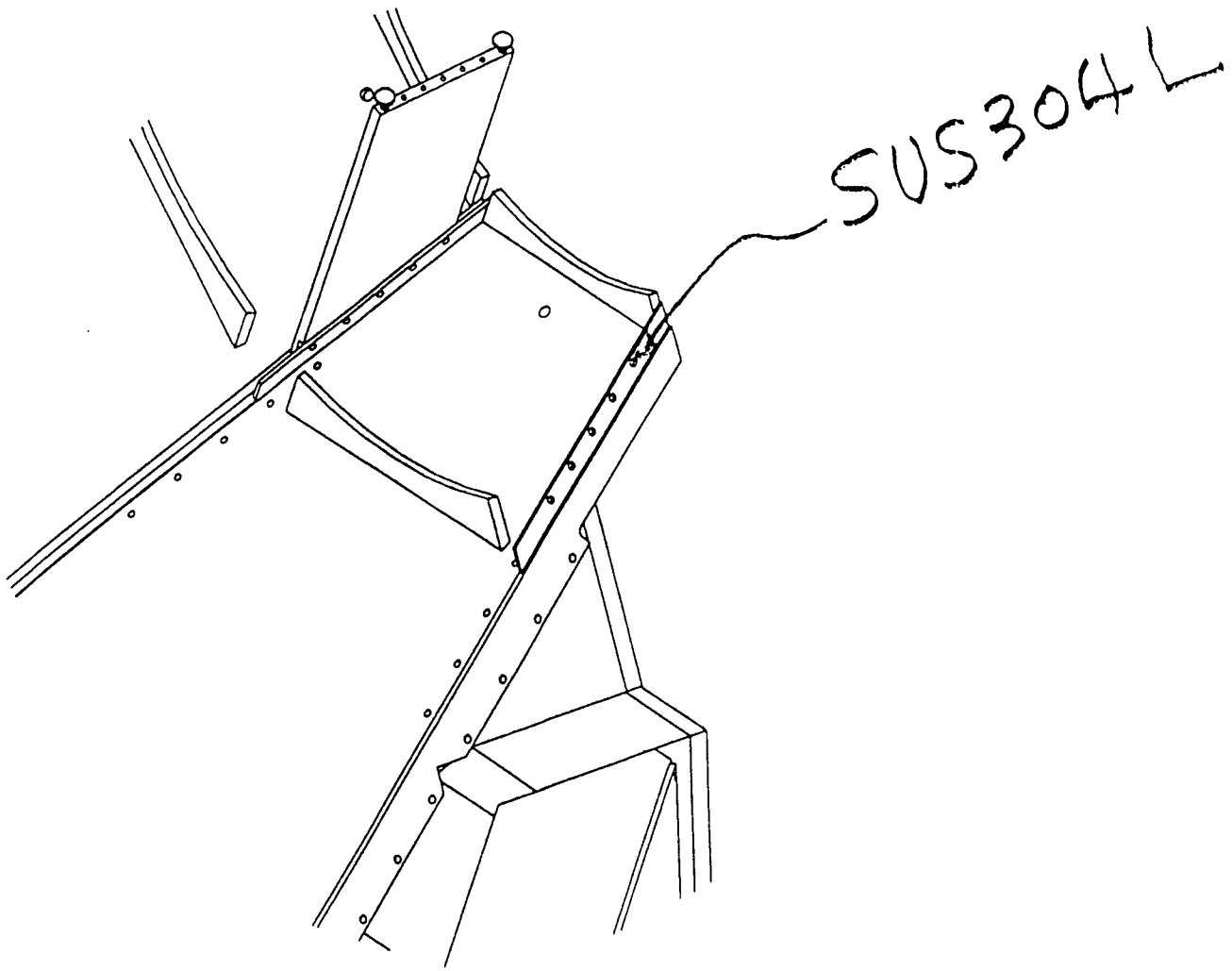
3.Lampshade-Lampshade



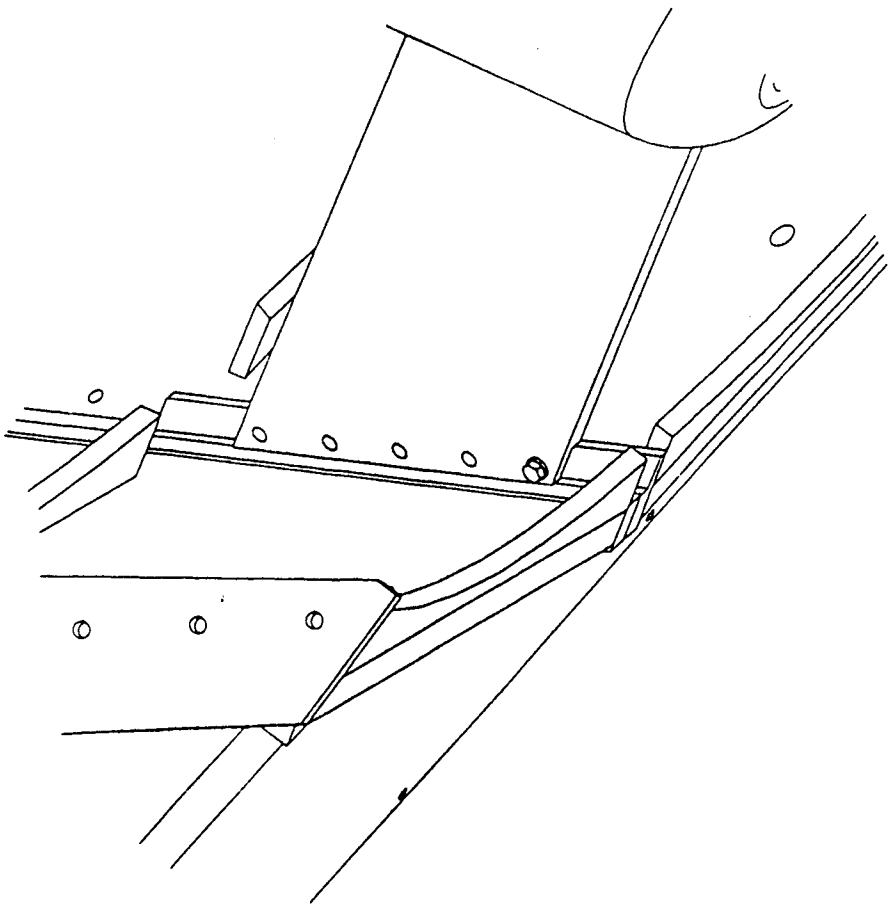
4.Lampshade-Backplate



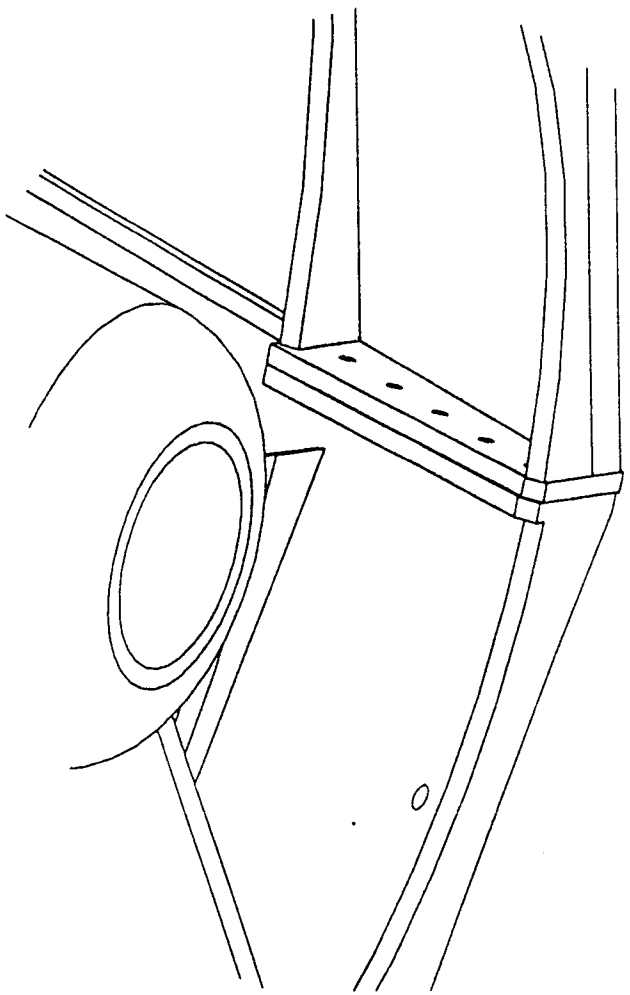
5.Lampshade-Gusset plate



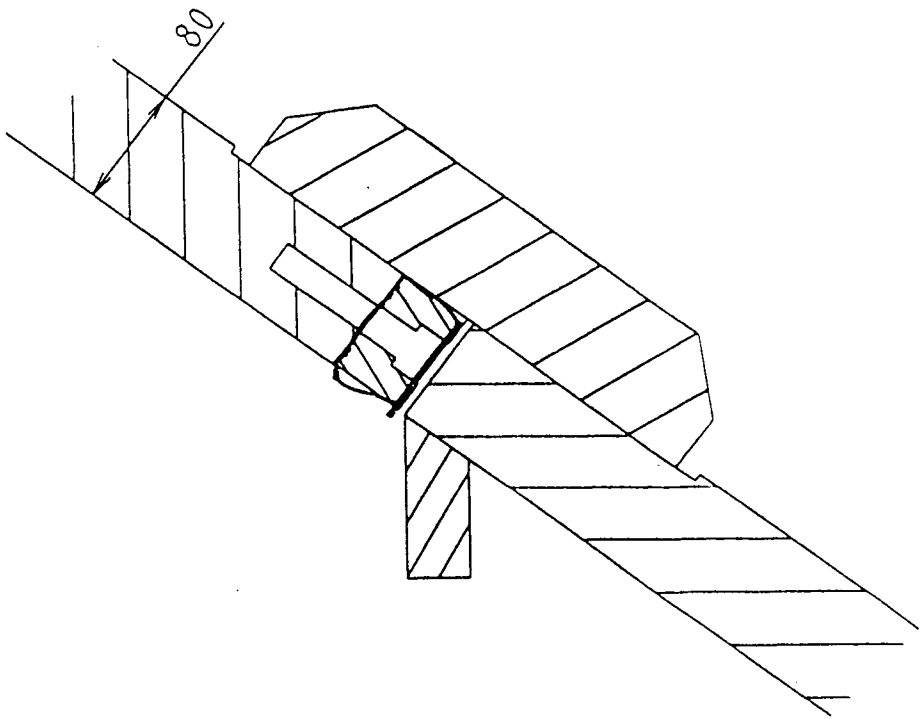
6.Lampshade-Fin support



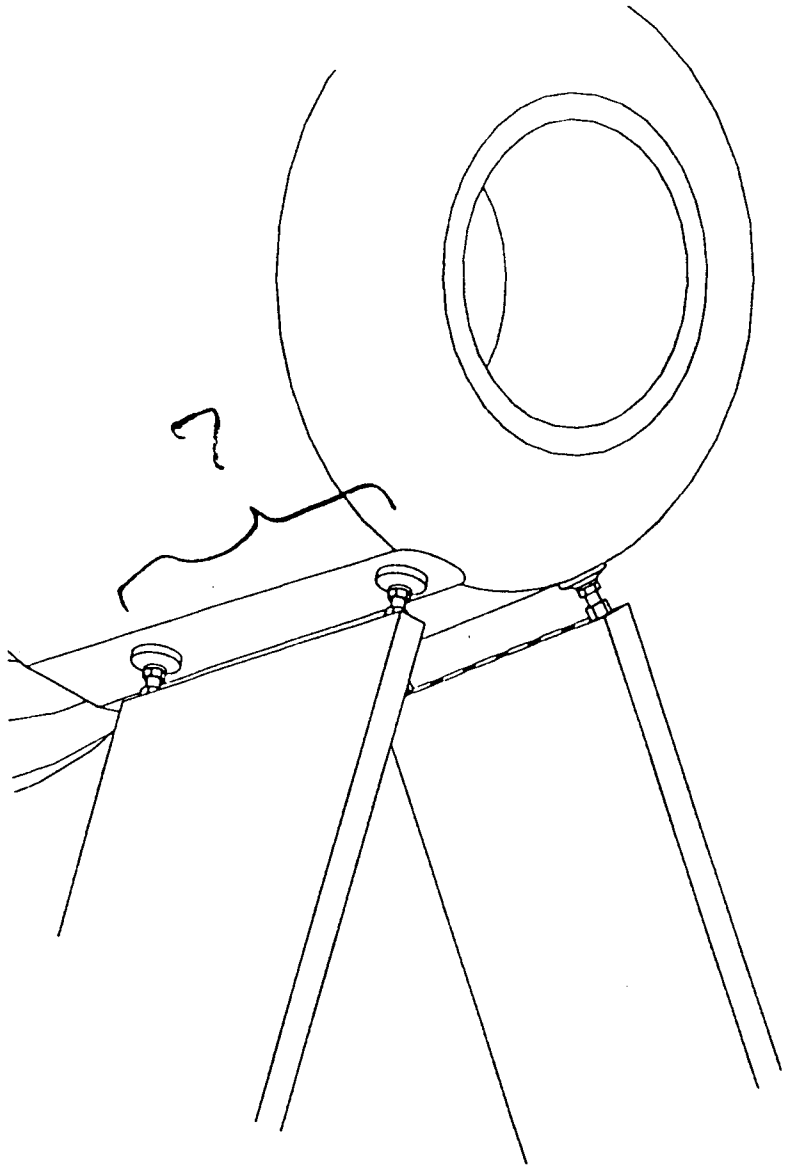
7.Lampshade-Teacup



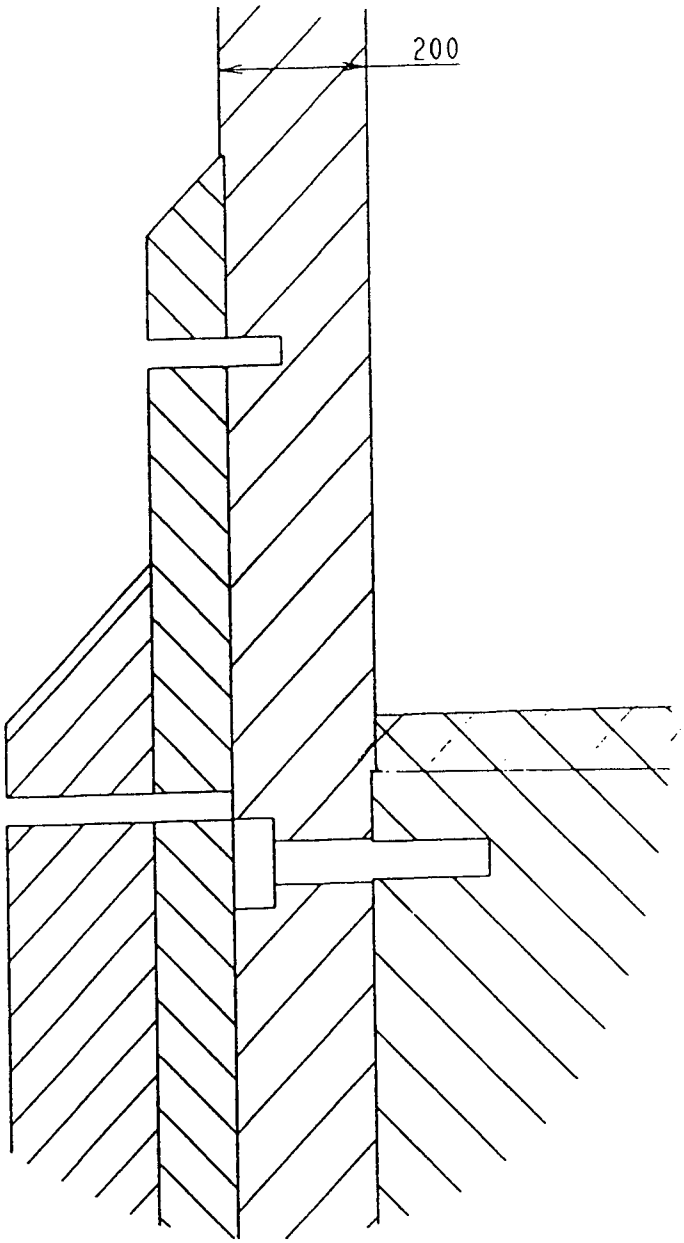
8.Lampshade-splice bar
spacer bar



9.Piston-Fin



10.Piston-Backplate



Surface preparation (Steel)

- *The primer to prepare depends on the resin of final coat.*
- *What kind of resin will be used at BNL?*
  - *alkyd, acrylate, epoxy, poly-urethane, and so on?*
- *Mitsubishi standard rust prevention primer of steel, 'RUSTITE(TM) NC No.90' has the following feature.*
  - *1)Pollution free (Without Cr and Pb, zinc chromate)*
  - *2) Alkyd resin system*
  - *3) Quick-drying*
  - *4) Wide selection of final coats*

Coil design

- Insulation method
- Insulation system
- Winding
- Surface preparation (Coil)
- Coil parameters

Insulation method 1)

- *1) pre-preg and 2) vacuum impregnation are very popular as the insulation method.*
- *Manufacturing flow of them is shown in the next transparency.*

Manufacturing flow of MMS coils

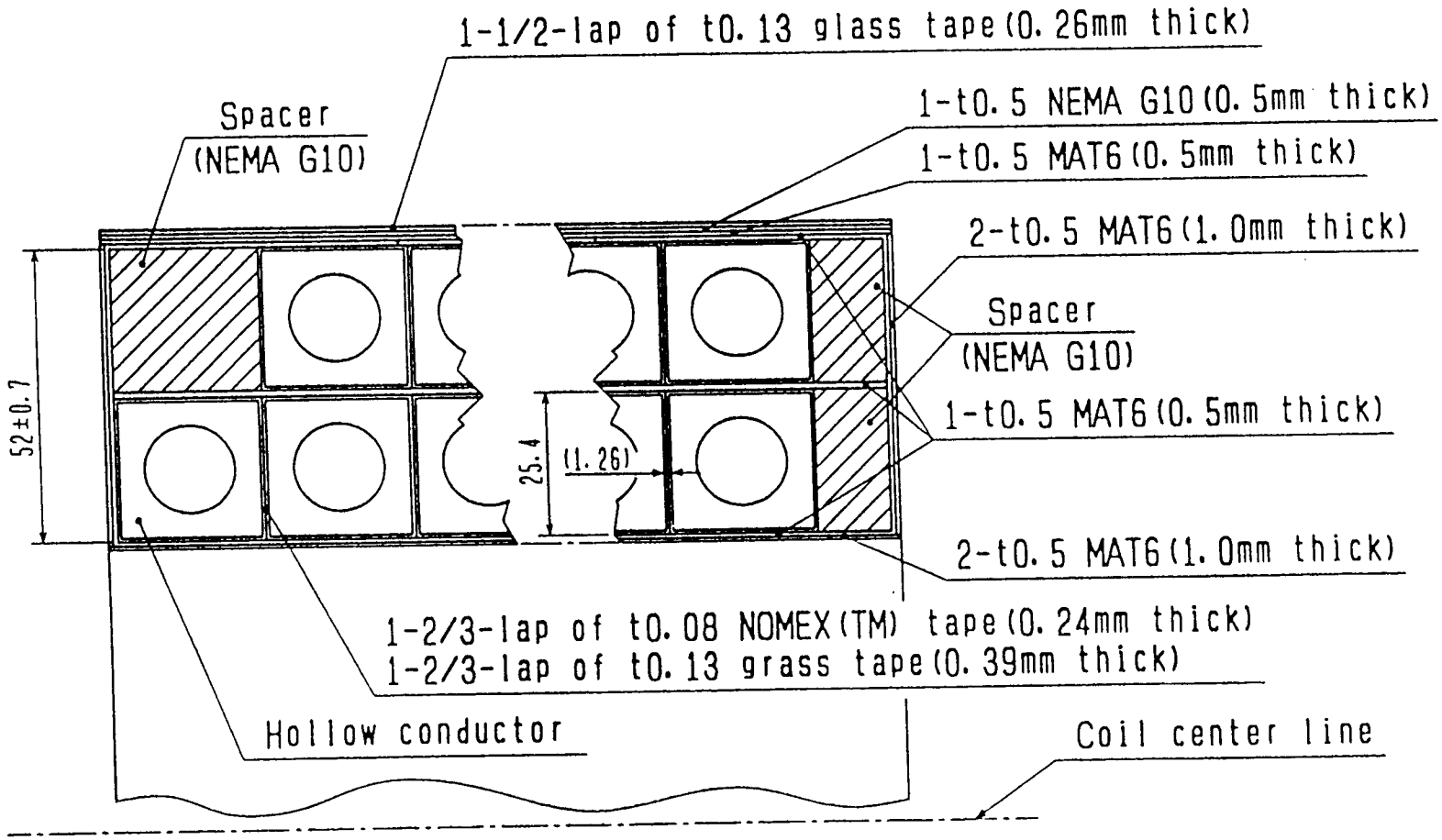
- *Pre-preg*
- *1) Winding and Taping*
- *2) Layer to Layer Insulation*
- *3) Ground Insulation*
- *8) Pressing and Curing*
- *9) Finishing and Shipping*

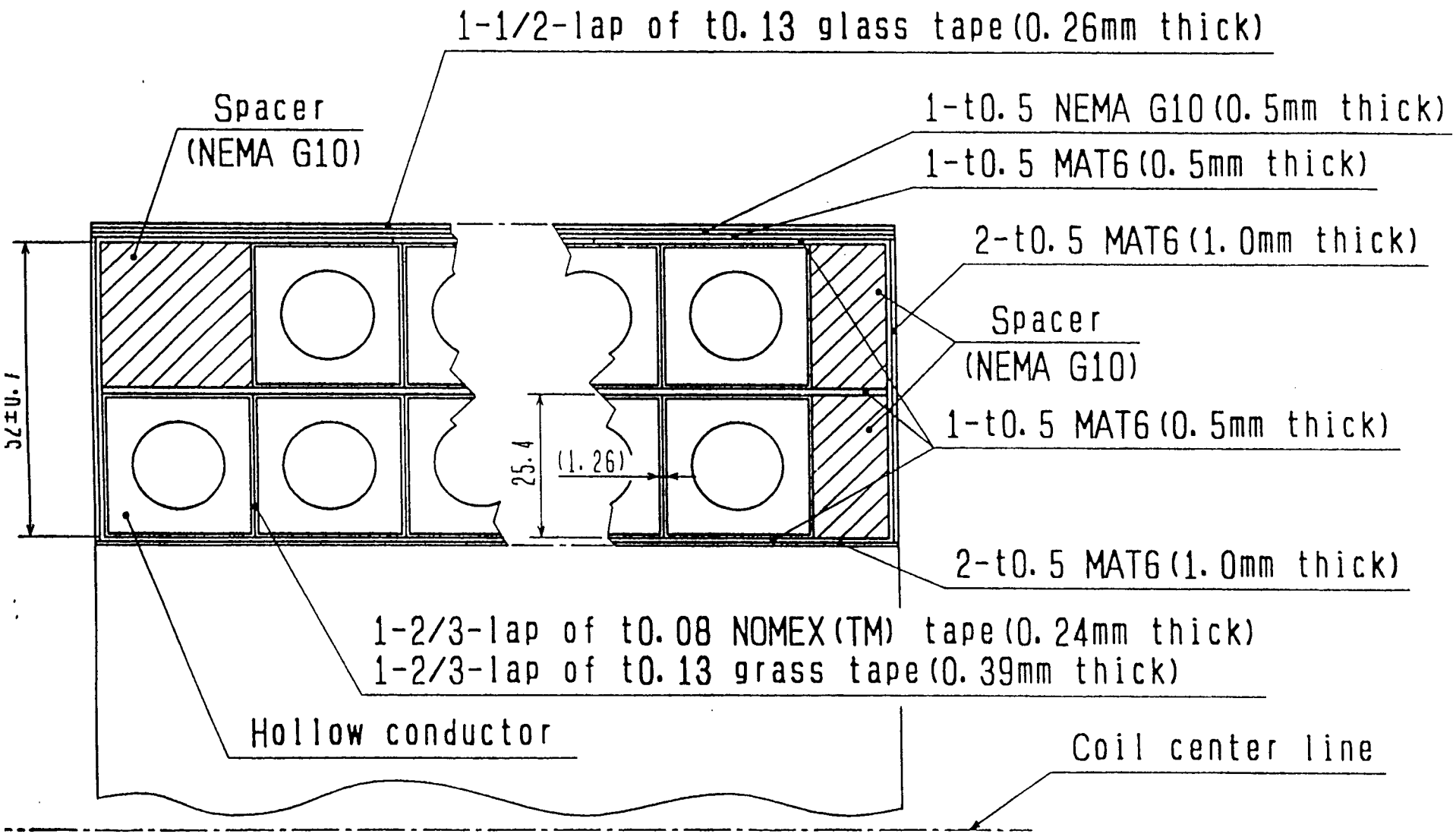
- *Vacuum Impregnation*
- *1) Winding and Taping*
- *2) Layer to Layer Insulation*
- *3) Ground Insulation*
- *4) Drying (in a vacuum)*
- *5) Degassing (in a vacuum)*
  - *Resin Storage*
    - *a) Temperature and viscosity control and degassing*
    - *b) Freezing Storage*
- *6) Resin Pouring*
- *7) Pressurized Impregnation*
- *8) Pressing and Curing*
- *9) Finishing and Shipping*

Insulation method 2)

- **Pre-preg features**
  - comparing with vacuum impregnation
    - 1) Manufacturing flow and jigs is simpler.
    - 2) Complicated control of resin is not necessary.
    - 3) Handling liquid resin is not necessary,
      - so that it is hygienic, non-polluting and safe against fire.
    - 4) Resin of larger coefficient of viscosity can be selected,
      - so that wide range of requirements concerning physical(thermal), chemical, mechanical and electrical property can be covered

Insulation system 2)




1-1/2-lap of t0.13 glass tape(0.26mm thick)
Spacer
(NEMA G10)
1-t0.5 NEMA G10(0.5mm thick)
1-t0.5 MAT6(0.5mm thick)
2-t0.5 MAT6(1.0mm thick)
Spacer
(NEMA G10)
1-t0.5 MAT6(0.5mm thick)
2-t0.5 MAT6(1.0mm thick)
25.4
(1.26)
1-2/3-lap of t0.08 NOMEX(TM) tape(0.24mm thick)
1-2/3-lap of t0.13 grass tape(0.39mm thick)
Hollow conductor
Coil center line

Insulation system 1)

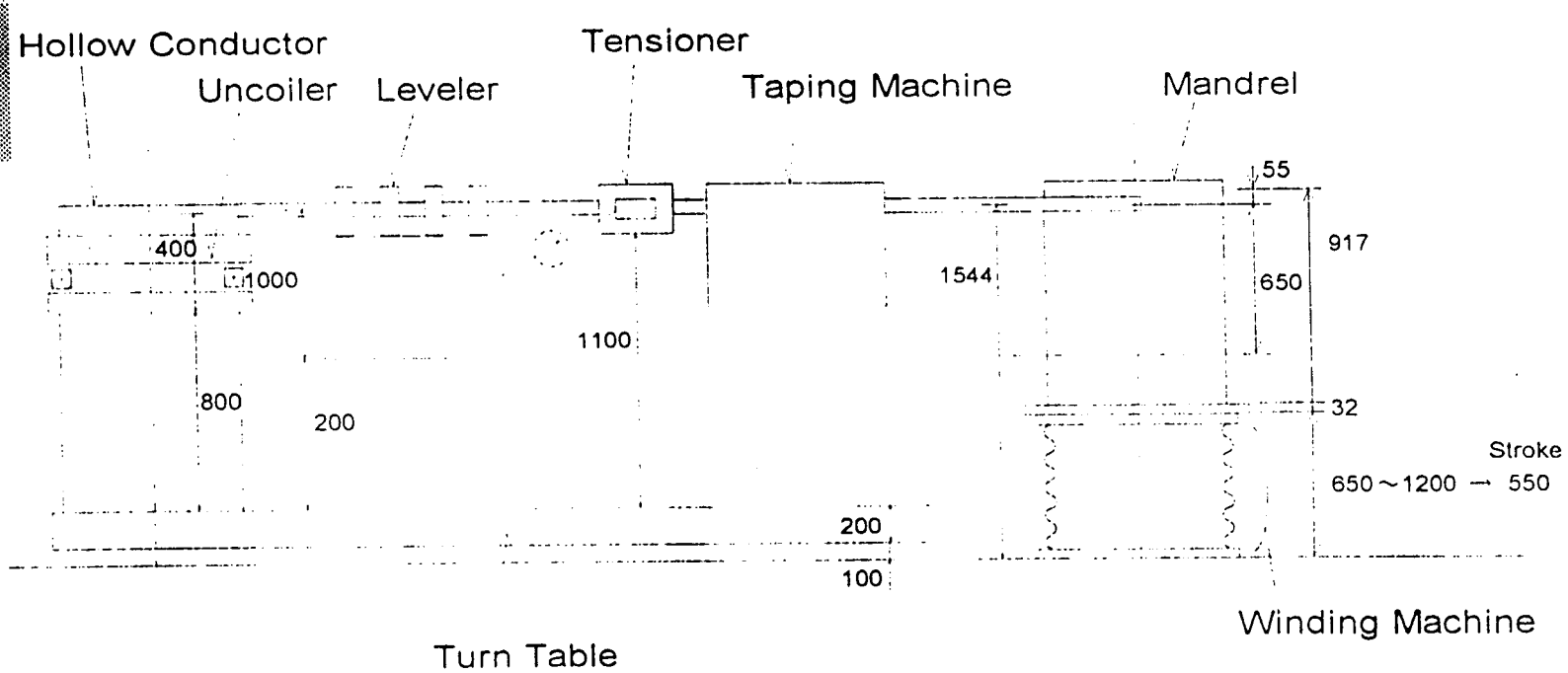
- **Turn to turn insulation**
  - 1-2/3-lap of NOMEX(TM) tape(0.24mm thick)
  - 1-2/3-lap of glass tape(0.39mm thick)
    - Total thickness of turn to turn insulation is about 1.26mm
- **Layer to layer insulation**
  - 1-t0.5 MAT6 (0.5mm thick)
- **Ground insulation** ((1):detector side, (2):piston side)
  - (1) 2-t0.5 MAT6 (0.5mm thick)
  - 1-t0.5 NEMA G10 (0.5mm thick)
  - 1-1/2-lap of glass tape(0.26mm thick)
  - (2) 3-t0.5 MAT6 (1.0mm thick)

1.76mm

1.5mm

Winding

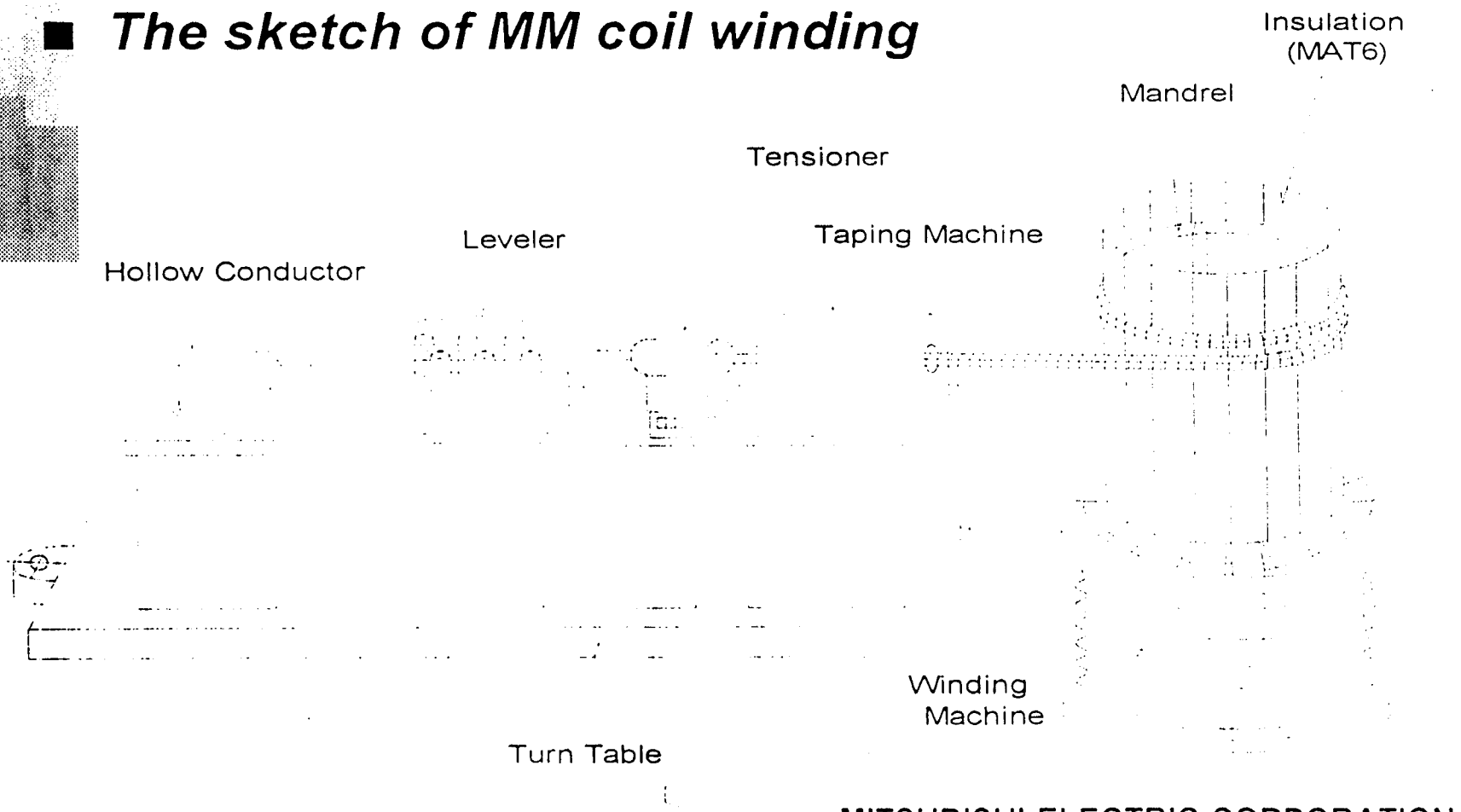
■ The scheme drawing of MM coil winding



MITSUBISHI ELECTRIC CORPORATION

Winding

■ The sketch of MM coil winding



MITSUBISHI ELECTRIC CORPORATION

Surface preparation (Coil)

- *Mitsubishi usually paints the coil surface for waterproofing and makeup.*
- *The paint called 'Red varnish' in Mitsubishi is also electrically resistible.*
- *'Red varnish' mainly consists of epoxy resin and two kinds of pigments as follows,*
  - *Ferric oxide red (Fe_2O_3) used for red coloring*
  - *Calcium carbonate ($CaCO_3$) used for increasing the hardness of coating.*

Coil parameters (Spec.)

Item	Front Coil	Rear Coil
AT	133,339 AT	253,024 AT
Current	2,300 A	2,300 A
Number of Turns	57 turn/coil	114 turn/coil
Inner Diameter	ϕ1,406.6 mm	ϕ1,610.6 mm
Outer Diameter	ϕ1,530.0 mm	ϕ1,785.5 mm
Coil Length	586 mm	606 mm
Conductor Cross Section	18.5 x 18.5 -ϕ11.5	18.5 x 18.5 -ϕ11.5
Conductor Material	Oxygen Free Copper	Oxygen Free Copper
Resistance (at 20 deg C)	19.2 mΩ	44.3 mΩ
Voltage	44.8 V	104.0 V
Joule Loss	101.4 kW	234.5 kW
No. of Water Circuits	8	16
Water Flow Rate	181.3 l/min	334.3 l/min
Water Temperature Rise	8.1 deg C	10.2 deg C

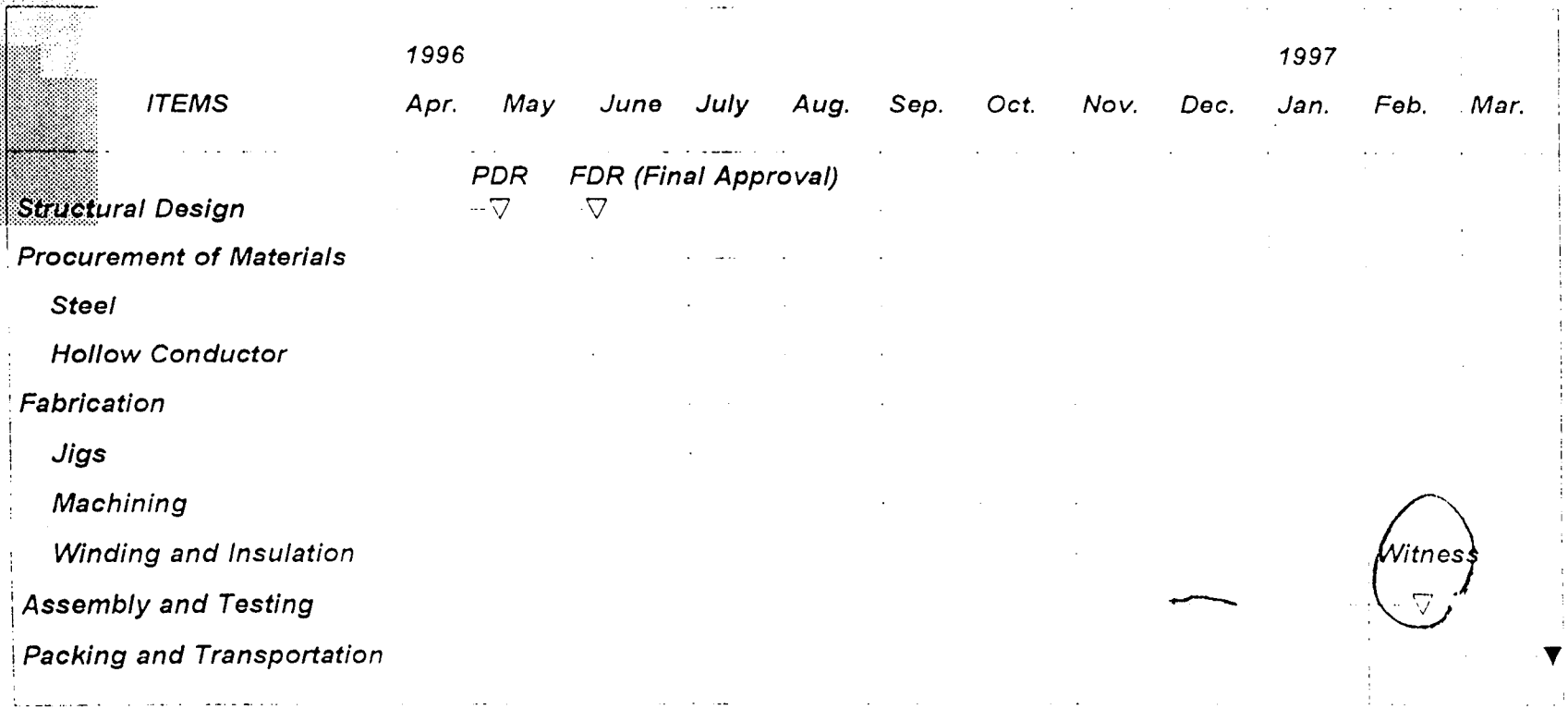
Coil parameters (Proposal)

	Design Value		
Item	Front Coil	Rear Coil	
		Inner Double Layer	Outer Double Layer
AT	131100 AT	135700 AT	126500 AT
Current	2300 A	2300 A	2300 A
Number of Turns	57 turn/coil	59 turn/coil	55 turn/coil
Inner Diameter	ϕ1406.6 mm	ϕ1610.6 mm	———
Outer Diameter	ϕ1530.0 mm	———	ϕ1780.8 mm
Coil Length	586 mm	606 mm	567 mm
Conductor Cross Section	18.5 x 18.5 -ϕ11.5	18.5 x 18.5 -ϕ11.5	18.5 x 18.5 -ϕ11.5
Conductor Material	Oxygen Free Copper	Oxygen Free Copper	Oxygen Free Copper
Resistance (at 20 deg C)	19.2 mΩ	22.3 mΩ	21.9 mΩ
Voltage	44.8 V	51.4 V	50.3 V
Joule Loss	101.4 kW	118.2 kW	115.8 kW
No. of Water Circuits	8	8	8
Water Flow Rate	181.3 l/min	166.7 l/min	163.3 l/min
Water Temperature Rise	8.1 deg C	10.2 deg C	10.2 deg C

Factory test and inspection

	Item	Specification	Remarks
General	Dimensional Inspection	as Drawings	
	Assembly		Witness
Coil	Resistance	Design value +/- 5%	
	Insulation Resistance	over 10MΩ	
	Pressure Drop	under Design value + 5%	
	Dielectric Test	DC 1500V 1min.	
	Magnetic Field	Several points	Witness
	Measurement	Current 20% ~100% rating	

MMS manufacturing schedule

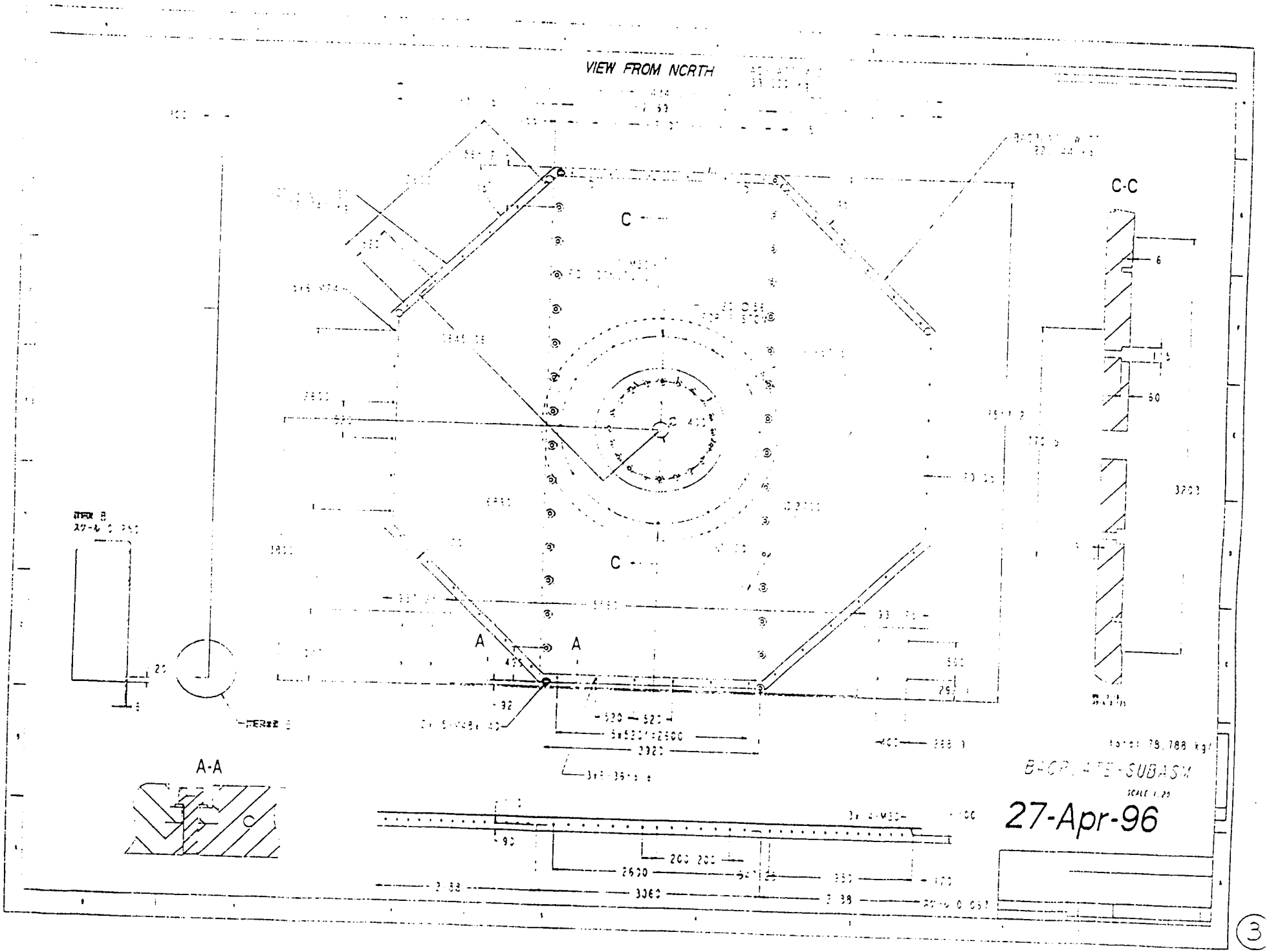


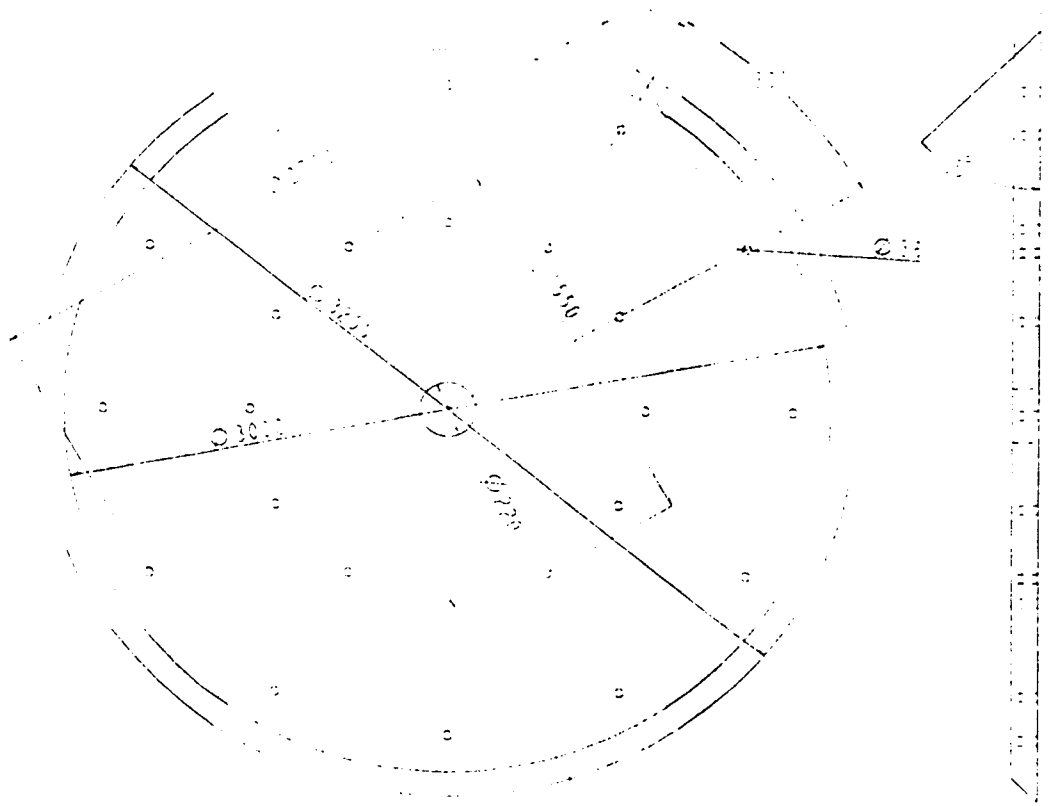
MITSUBISHI ELECTRIC CORPORATION

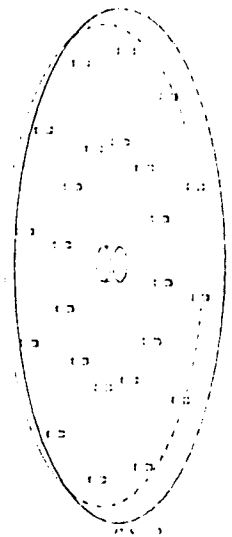
Drawings

- ***Machining commercial tolerance (Mitsubishi)***

Devision of dimension			Medium	Coarse
	0.5 TO	3	+/- 0.1	
OVER	3 TO	6	+/- 0.1	+/- 0.2
OVER	6 TO	30	+/- 0.2	+/- 0.5
OVER	30 TO	120	+/- 0.3	+/- 0.8
OVER	120 TO	315	+/- 0.5	+/- 1.2
OVER	315 TO	1000	+/- 0.8	+/- 2.0
OVER	1000 TO	2000	+/- 1.2	+/- 3.0
OVER	2000 TO	4000	+/- 1.8	+/- 4.5
OVER	4000 TO	6300	+/- 2.5	+/- 5.0
OVER	6300 TO	10000	+/- 3.5	+/- 6.3


VIEW FROM NORTH
C-C
A-A
27-Apr-96





27-Apr-96

RHIC/PHENIX DETECTOR

Muon Magnet South - Finite Element Analysis

Preliminary Design Review
May 1, 1996

BNL, LLNL, Mitsubishi Electric Corp., RIKEN

Finite Element Analysis - Muon Magnet South

Static Analysis - 1g gravity load

- Maximum Displacements

	Y - axis .	Z-axis
Piston - End	- .027 in. [.686 mm]	.022 in.[.589 mm]
Backplate - Top	- .002 in.[.061 mm]	.057 in. [1.445 mm]

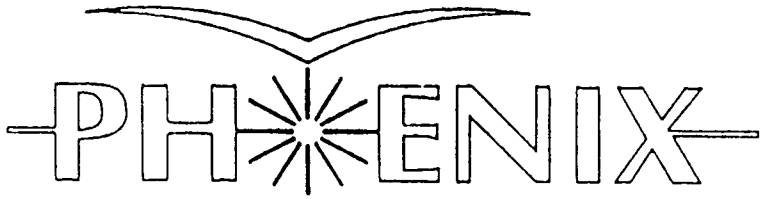
- Max Von Mises Stress on order of less than 1e+04 lbs/in^2

Modal Analysis

Non-Rigid body modes

- First mode between 5 Hz - 8 Hz
- Second mode 22.1 Hz
- Third mode 23.0 Hz

RHIC/PHENIX DETECTOR



PDR Update: Muon Magnet South

Tom Vercelli/Art Posey/Tony Ladran/Bob Yamamoto

representing the BNL, LANL, and LLNL Design Team

May 1, 1996

Lawrence Livermore National Laboratory

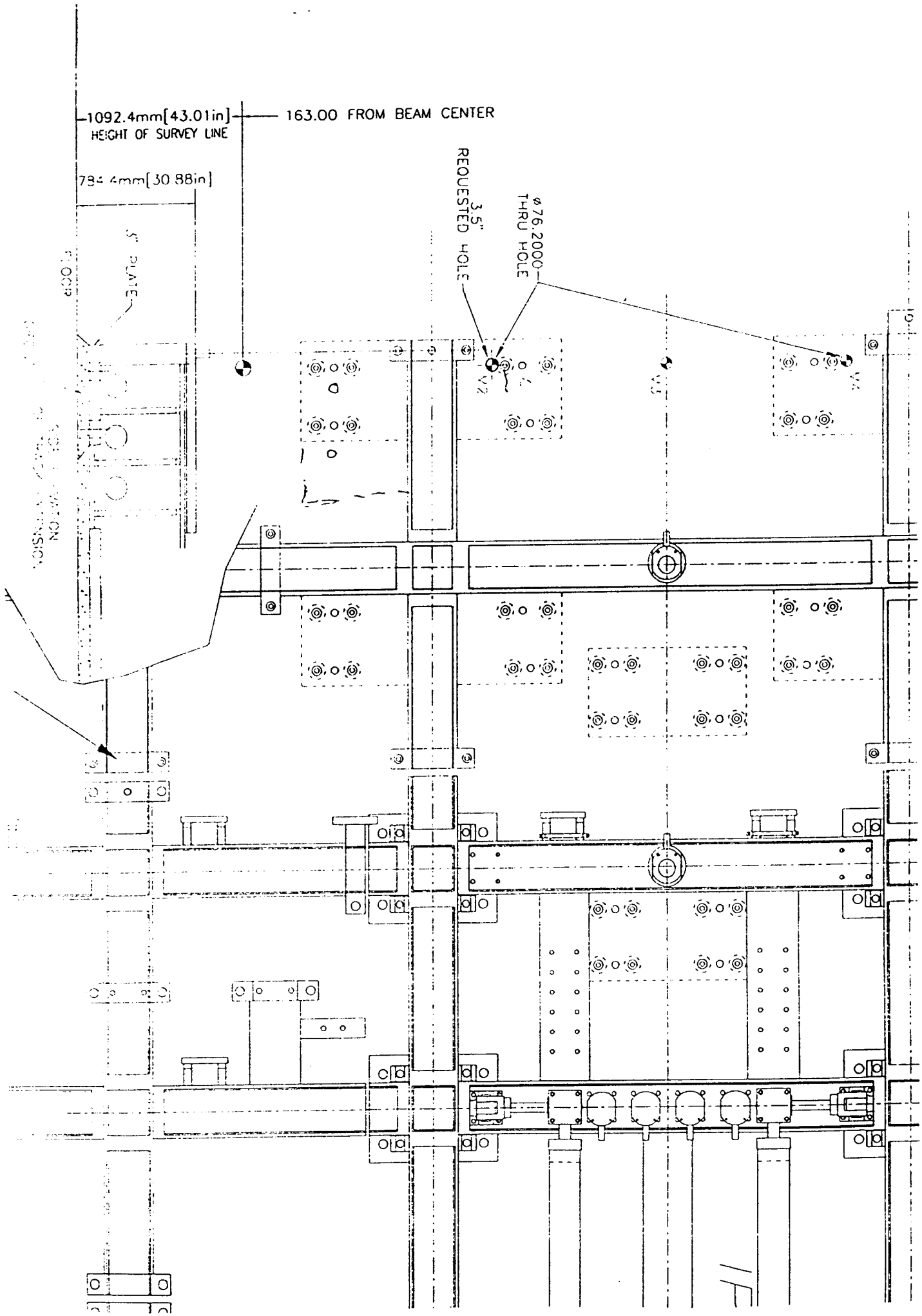
PHENIX MM South Design - Status: LLNL

- TRACK SYSTEM
  - MMS track system is "build to spec." per LLNL drawings; detail design will be done by LLNL, completion date est. is end of 6/96.
  - Design identical in concept to the CM track system.
  - Track layout is as shown on drawings dated 5/1/96.
  - Tracks incorporate anchor plates for vertical seismic restraints.

- SEISMIC RESTRAINTS
  - Design and analysis is complete.
  - The design is based on the CM restraint system.
  - Accessibility of the north-west horizontal restraint may require the west carriage to be retracted (west) during restraint installation.

- HYDRAULIC COMPONENTS
  - Cylinder design is complete, based on CM design except one attachment point; vendor quote still required.
  - Pancake jacks are specified.
  - Jack stands are required; design and analysis will be complete by end of 6/96.

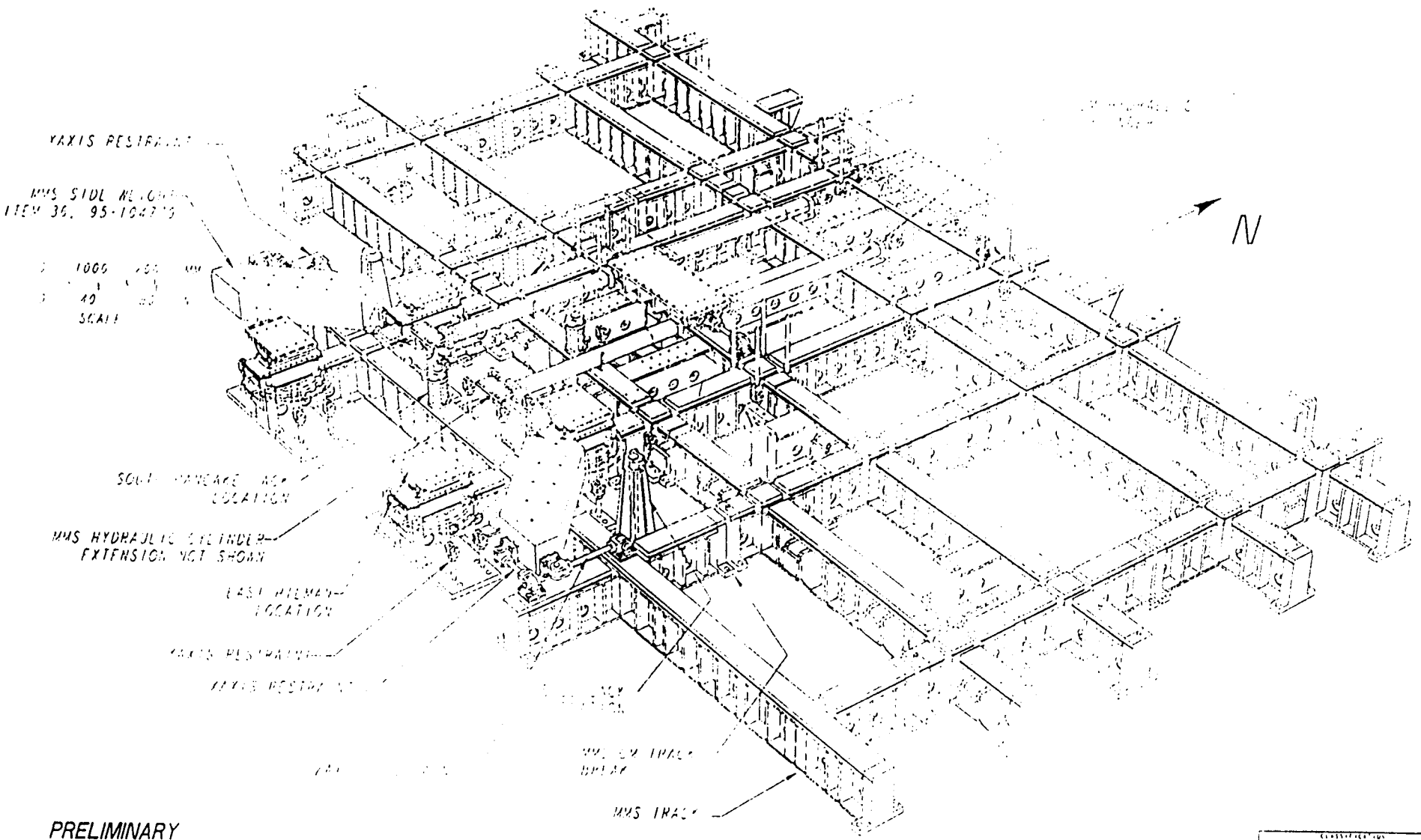
- BACK PLATE/BASE PLATE CONNECTION
  - Rigid connection of base plate to back plate is required.
  - 14 bolts per back plate section is proposed.
  - Bolt size and integration issues are being looked at.


1092.4mm[43.01in]
HEIGHT OF SURVEY LINE
163.00 FROM BEAM CENTER
784.4mm[30.88in]
3.5" REQUESTED HOLE
ø76.2000 THRU HOLE

PHENIX - SOUTH MUON MAGNET

MMS PARKED POSITION

30-Apr-96



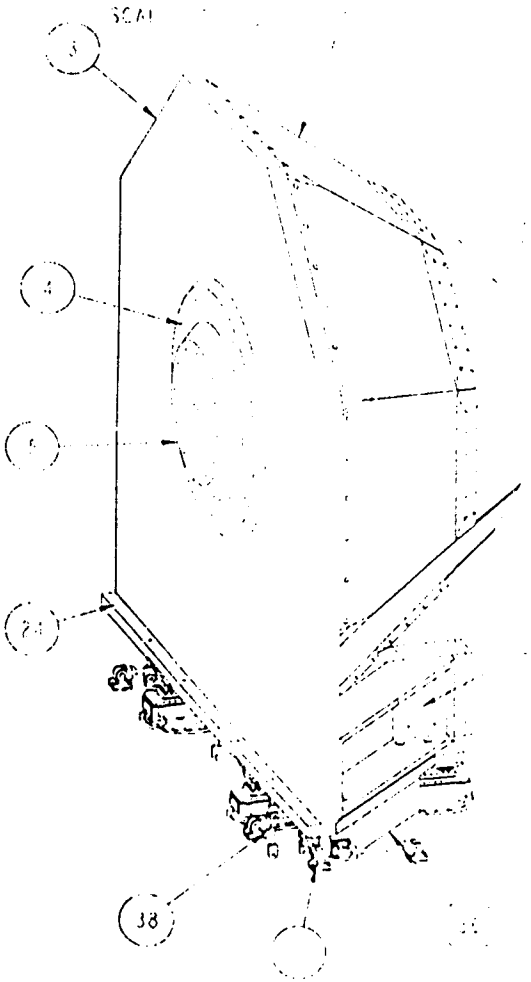
PRELIMINARY

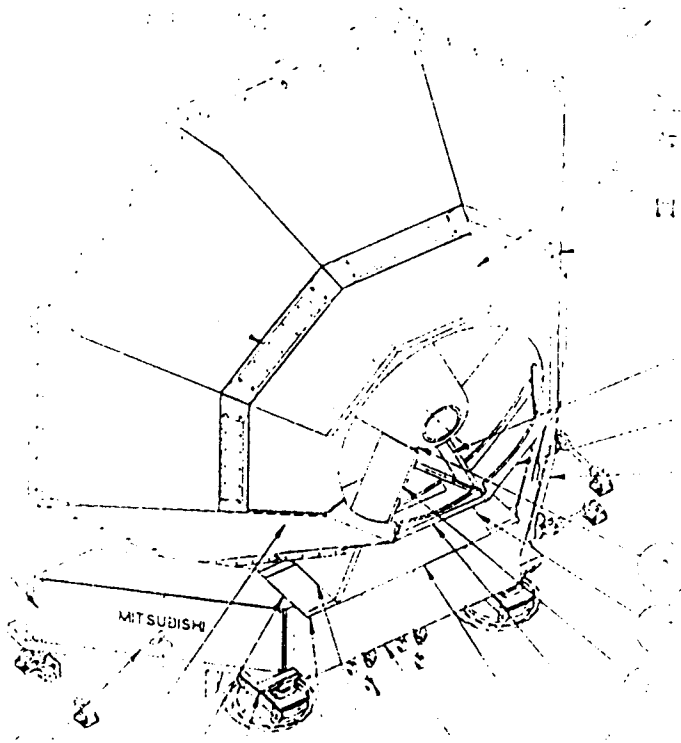
NOT FOR CONSTRUCTION

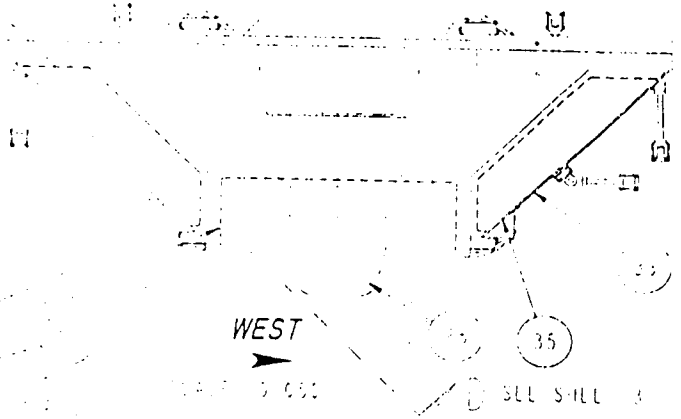
UNCLASSIFIED

DRAWING NO AAA95-XXXXXX-XX

1-May-96





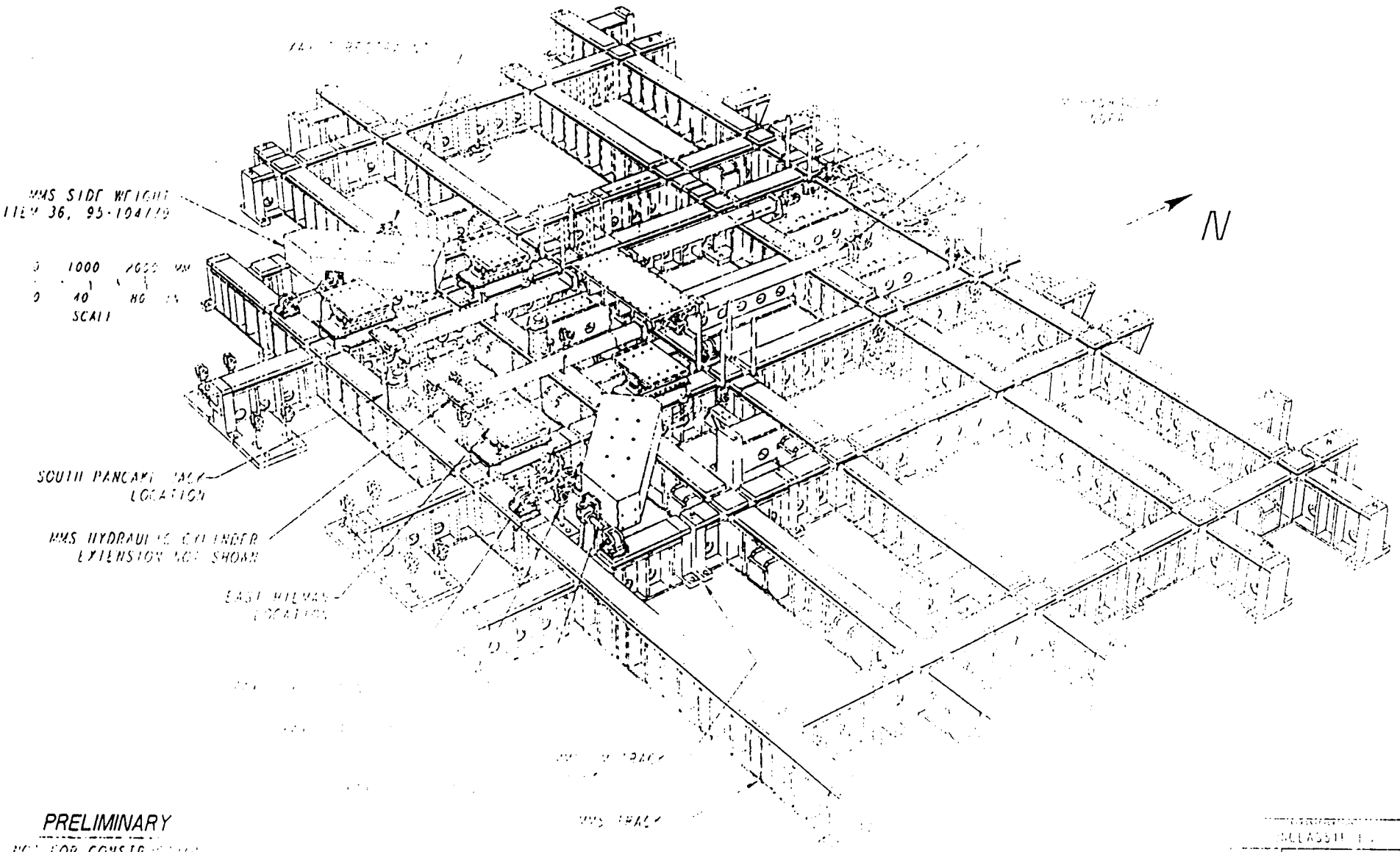


PRELIMINARY

PHENIX - SOUTH MUON MAGNET

MMS ENGAGED TRACK LOCATION

30-Apr-96

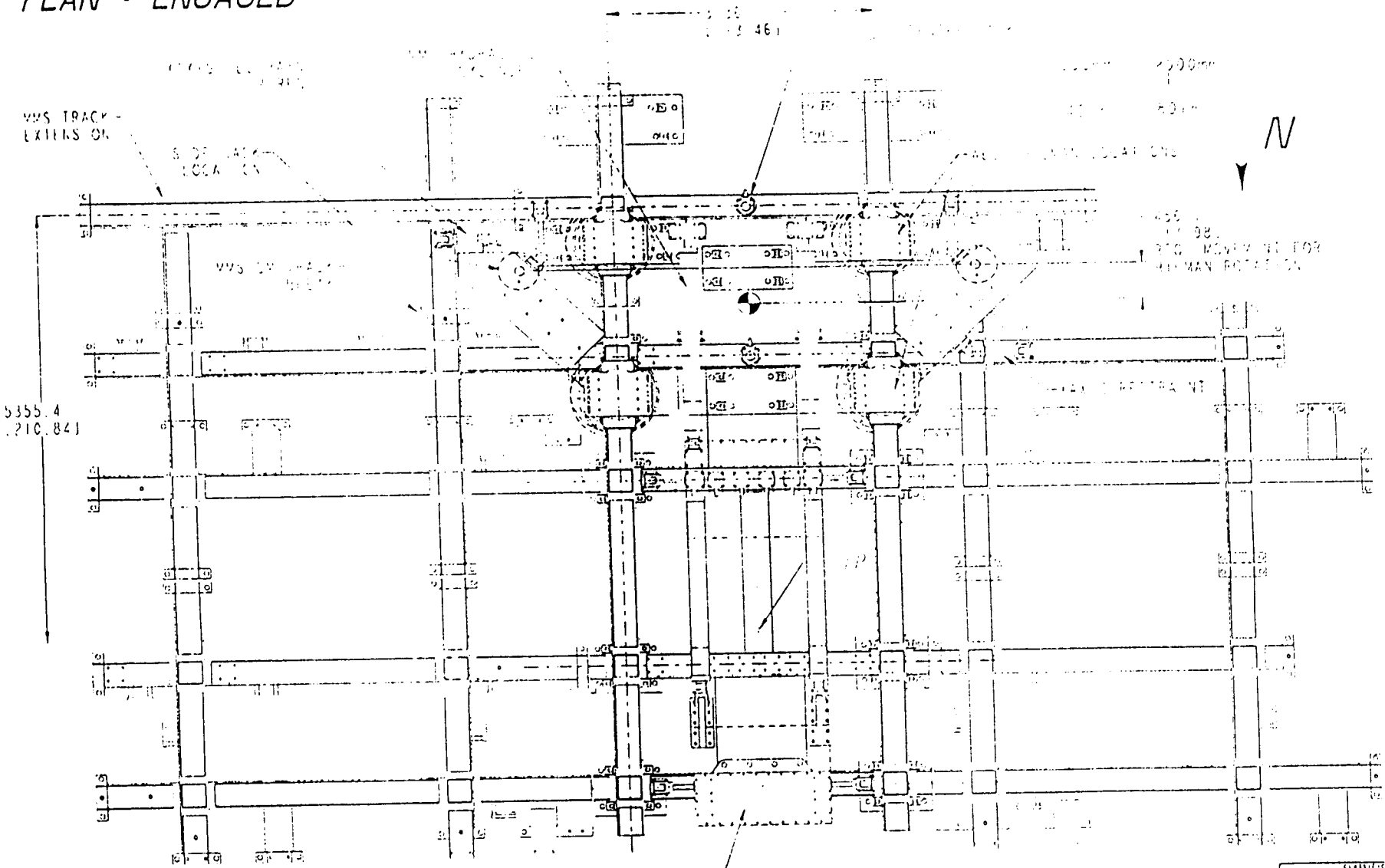


PRELIMINARY

PHENIX SOUTH MUON MAGNET

30-Apr-96

PLAN - ENGAGED

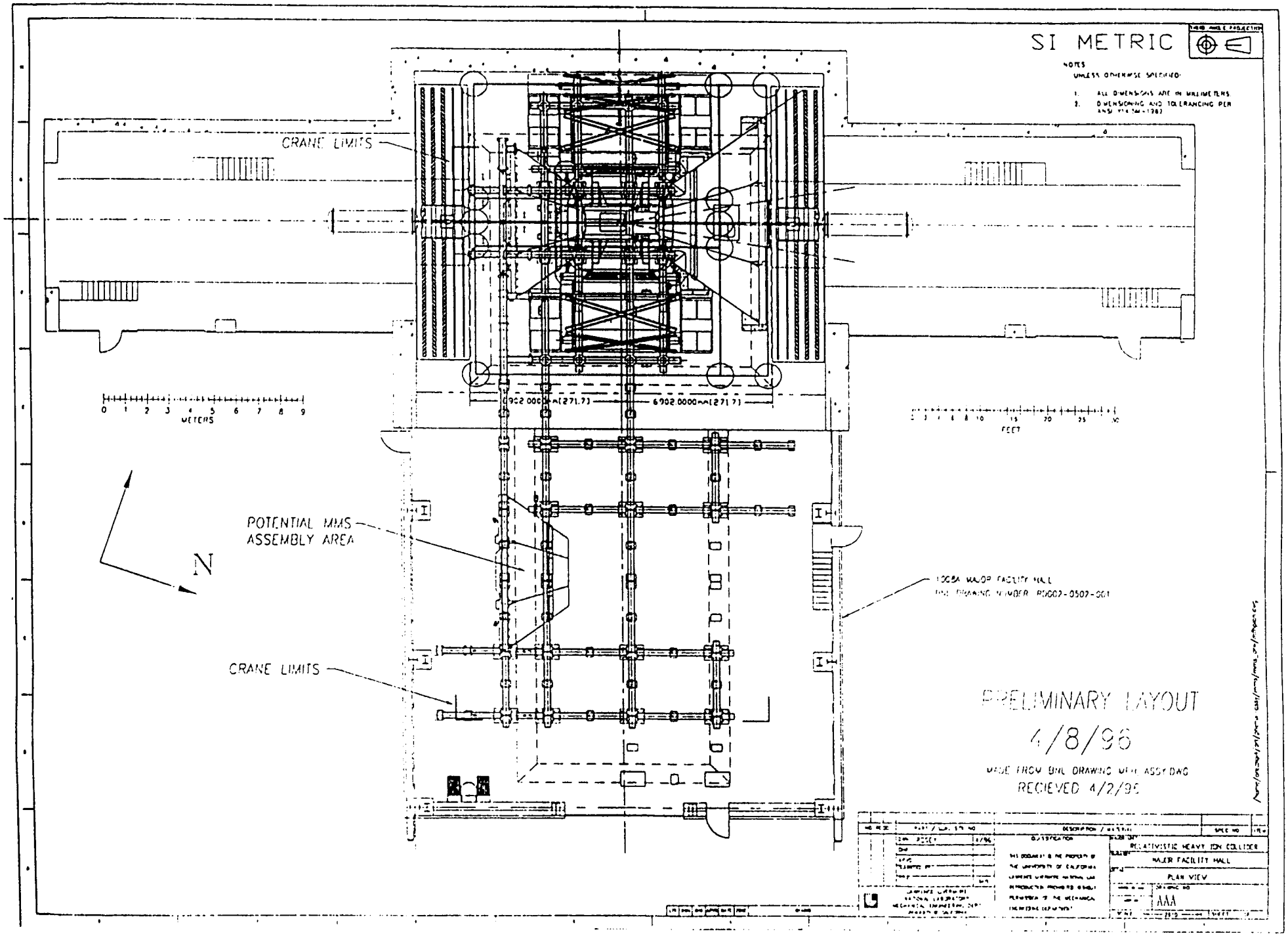


PRELIMINARY

NOT FOR CONSTRUCTION

UNCLASSIFIED

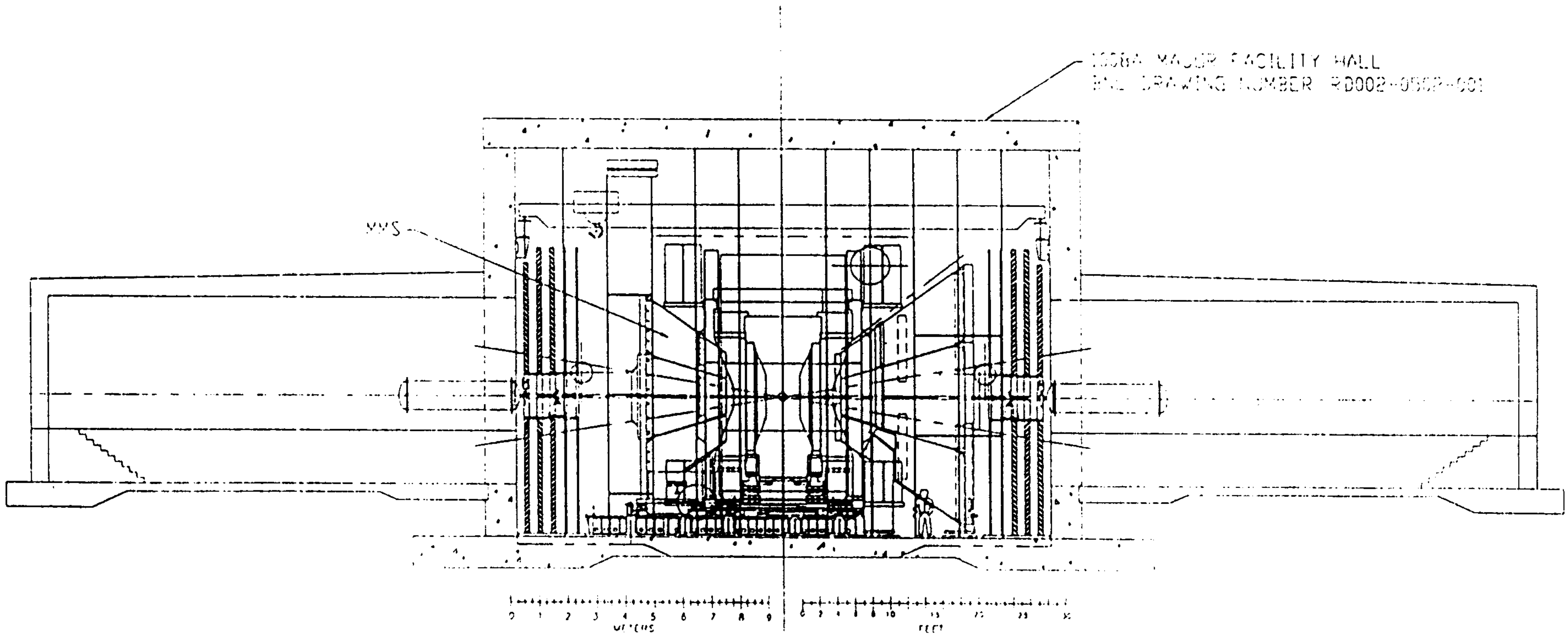
AAA95 104778-0C


SI METRIC
NOTES
UNLESS OTHERWISE SPECIFIED:
1. ALL DIMENSIONS ARE IN MILLIMETERS
2. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1982
CRANE LIMITS
6902.0000mm[271.7]
6902.0000mm[271.7]
0 1 2 3 4 5 6 7 8 9
METERS
FEET
N
POTENTIAL MMS ASSEMBLY AREA
CRANE LIMITS
PRELIMINARY LAYOUT
4/8/96
MADE FROM BNL DRAWING WITH ASSY DWG
RECIEVED 4/2/96
RELATIVISTIC HEAVY ION COLLIDER
MAJOR FACILITY HALL
PLAN VIEW
AAA

SI METRIC

NOTES
UNLESS OTHERWISE SPECIFIED

1. ALL DIMENSIONS ARE IN MILLIMETERS
2. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1982
3. SURFACE TEXTURE PER ANSI B46.1-1985
4. 3.2/ ALL MACHINED SURFACES
5. BREAK SHARP EDGES R.127 MAX OR CHAMFER



4/8/96

ELEVATION LOOKING WEST
PRELIMINARY LAYOUT

RECIEVED 4/2/9?

RELATIVISTIC HEAVY ION COLLIDER

MAJOR FACILITY HALL

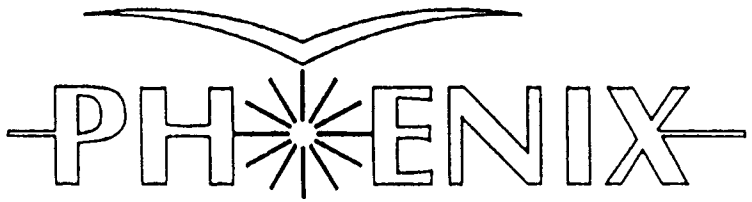
ELEVATION LOOKING WEST

LAWRENCE LIVERMORE NATIONAL LABORATORY
MECHANICAL ENGINEERING DEPT

AAA XX-XXXXXX-XX

SHEET 1 OF 1

RHIC/PHENIX DETECTOR



Muon Magnet South - Coils
Preliminary Design Review

Arthur R. Harvey
Robert M. Yamamoto

representing the BNL, LANL and LLNL Design Team

May 1, 1996

PHENIX MM South Coil - Status

- Coil (front/rear) is "build to spec." per LLNL specification/analysis; final design details/drawings will be done by Mitsubishi.
  - Design identical in concept to MM North Coil.
  - Coil will be fabricated by Mitsubishi Electric Corporation.
  - Copper conductor will be purchased by Mitsubishi.
  - Full current testing (2300 amps) will be done at Mitsubishi (with [redacted] steel).
  - BNL Rigging will install coil onto the MMS piston.
  - Facility interface is at bus bar/water manifold assemblies located on the Lower Lampshades.
  - Scheduled fabrication completion date is March '97.
  - "Strawman" magnetic test plan has been developed (same as MMN).

- Power Supply to be specified by LLNL (similar to CM & MMN):
  - Scheduled completion is TBD.
  - Final performance validation will commence Summer '97.

PHENIX Muon Magnet South - Coil Parameters

	Front Coil	Rear Coil
Amp-Turns	133,339	253,024
Configuration	2 Layer Solenoid Quadrafilar - Copper	4 Layer Solenoid Quadrafilar - Copper
Inside Radius (mm)	703.3	805.28
Outside Radius (mm)	765	892.74
# of Turns	57	114
Cond Size (mm)	18.47 square	18.47 square
Cond Hole ø (mm)	11.53	11.53
Current (amps)	2300	2300
Voltage (volts)	44.8	104
Power (kwatts)	103	239.2
Flow rate per circuit (gpm)	5.99	5.52
Flow rate total (gpm)	47.9	88.3
Water Flow Velocity (ft/sec)	11.9	10.9
Weight (kg)	554	1281
Outlet Water Temp °C	28.1	30.2

RMY-01
4/26/96

RHIC/PHENIX DETECTOR

Muon Magnet South - Finite Element Analysis

Preliminary Design Review
May 1, 1996

BNL, LLNL, Mitsubishi Electric Corp., RIKEN

Finite Element Analysis - Muon Magnet South

Static Analysis - 1g gravity load

- Maximum Displacements

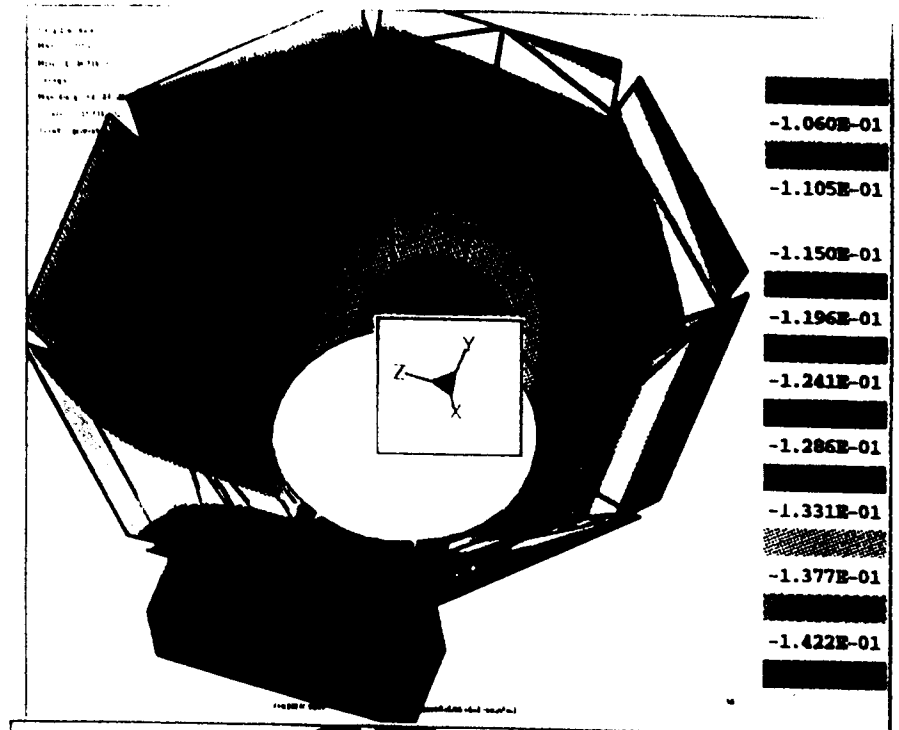
	Y - axis .	Z-axis
Piston - End	- .027 in. [.686 mm]	.022 in.[.589 mm]
Backplate - Top	- .002 in.[.061 mm]	.057 in. [1.445 mm]

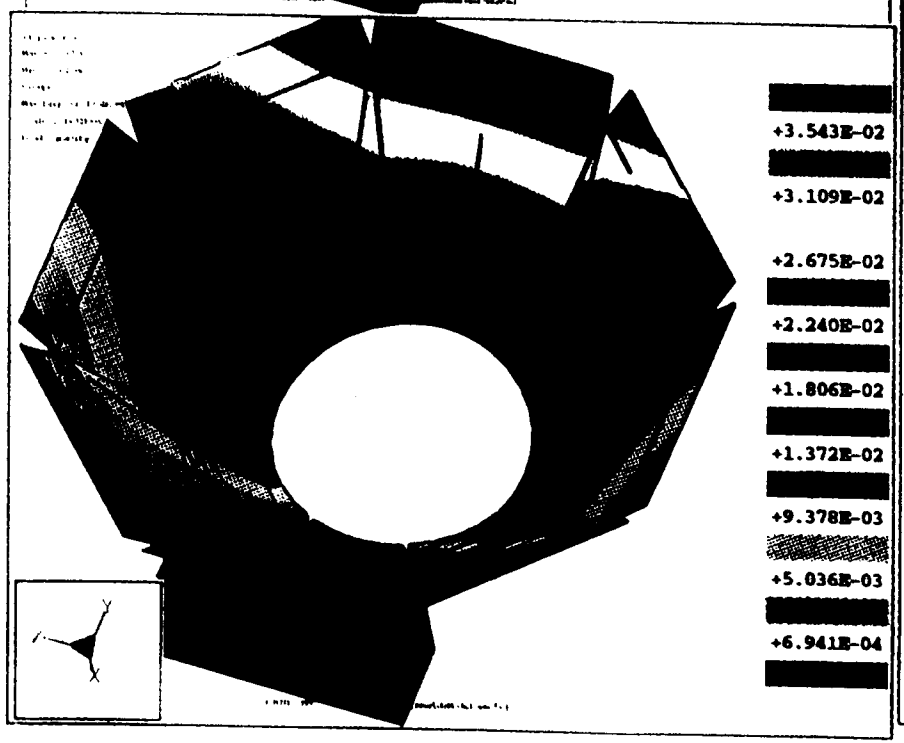
- Max Von Mises Stress on order of less than 1e+04 lbs/in^2

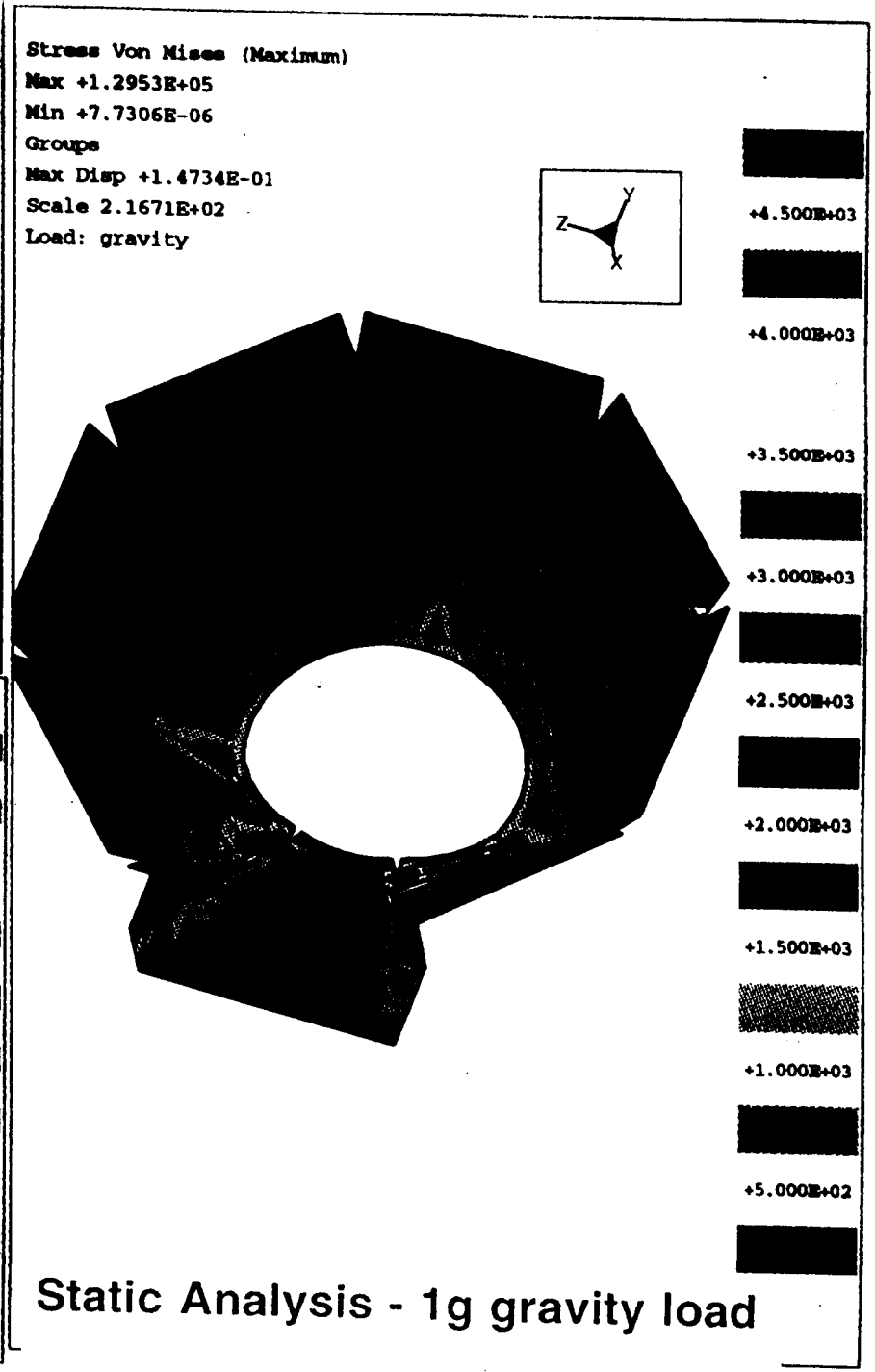
Modal Analysis

Non-Rigid body modes

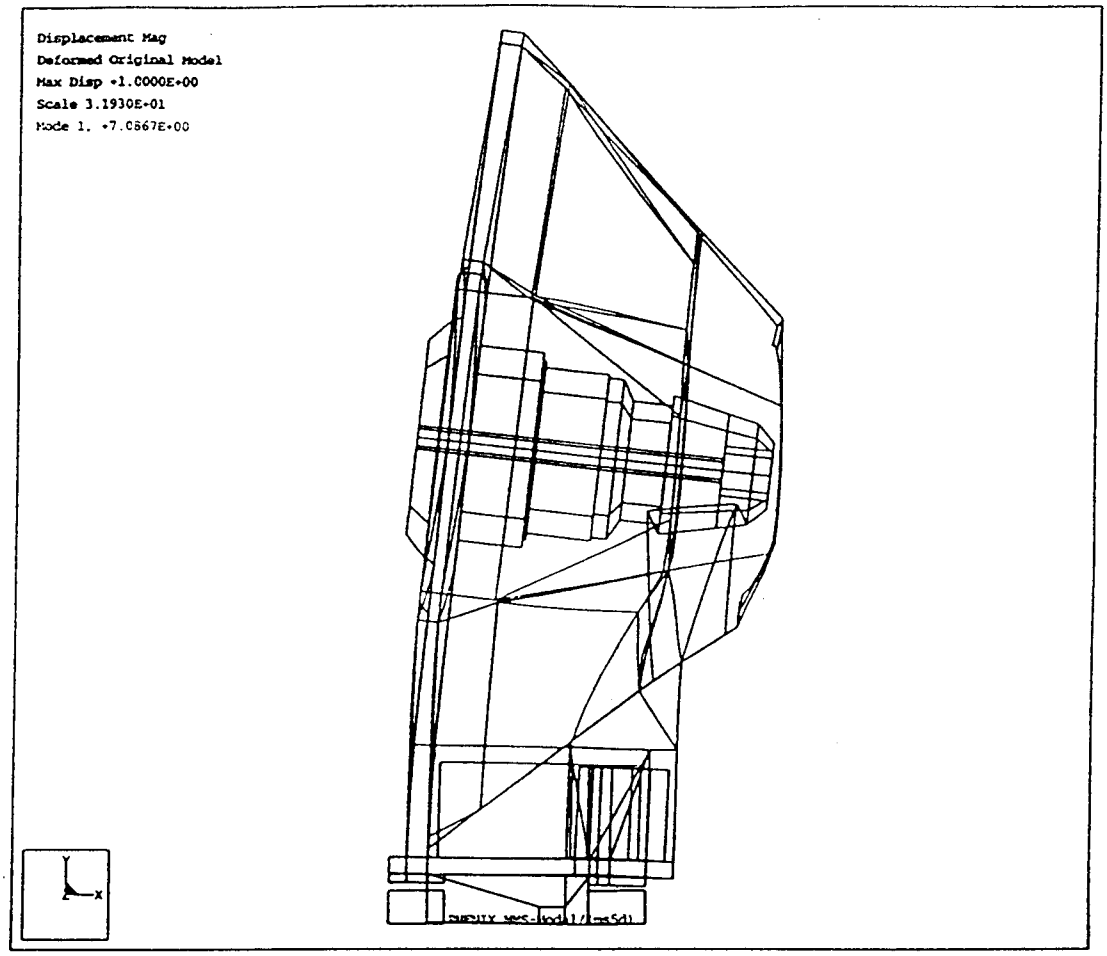
- First mode between 5 Hz - 8 Hz
- Second mode 22.1 Hz
- Third mode 23.0 Hz



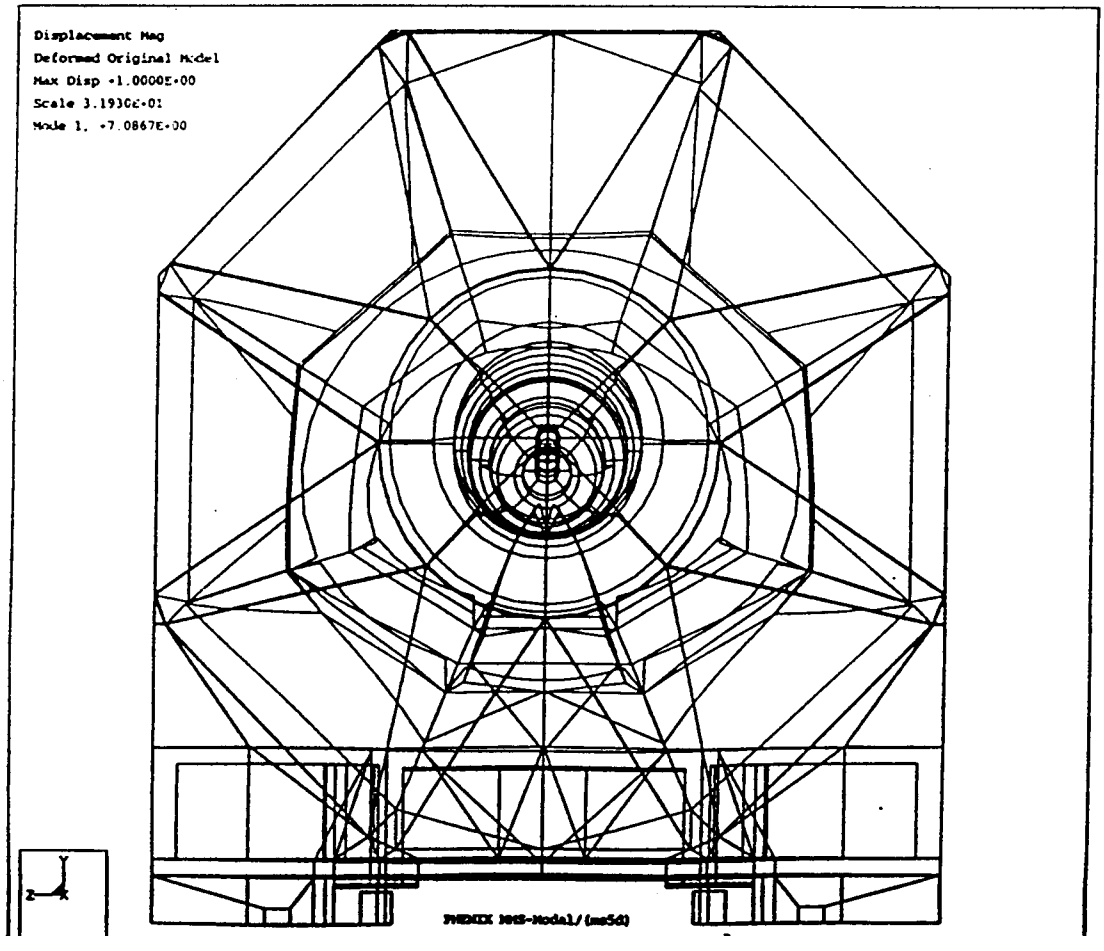


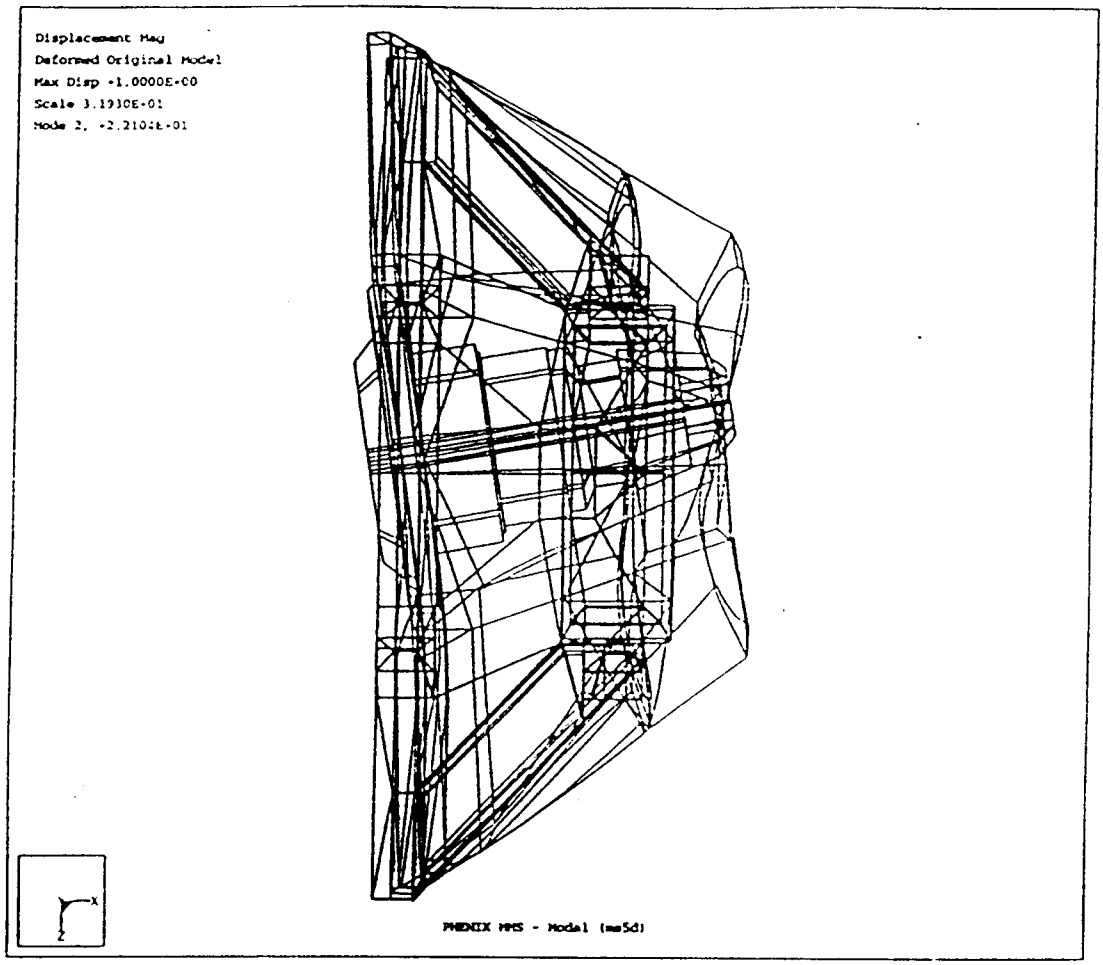


Static Analysis - 1g gravity load

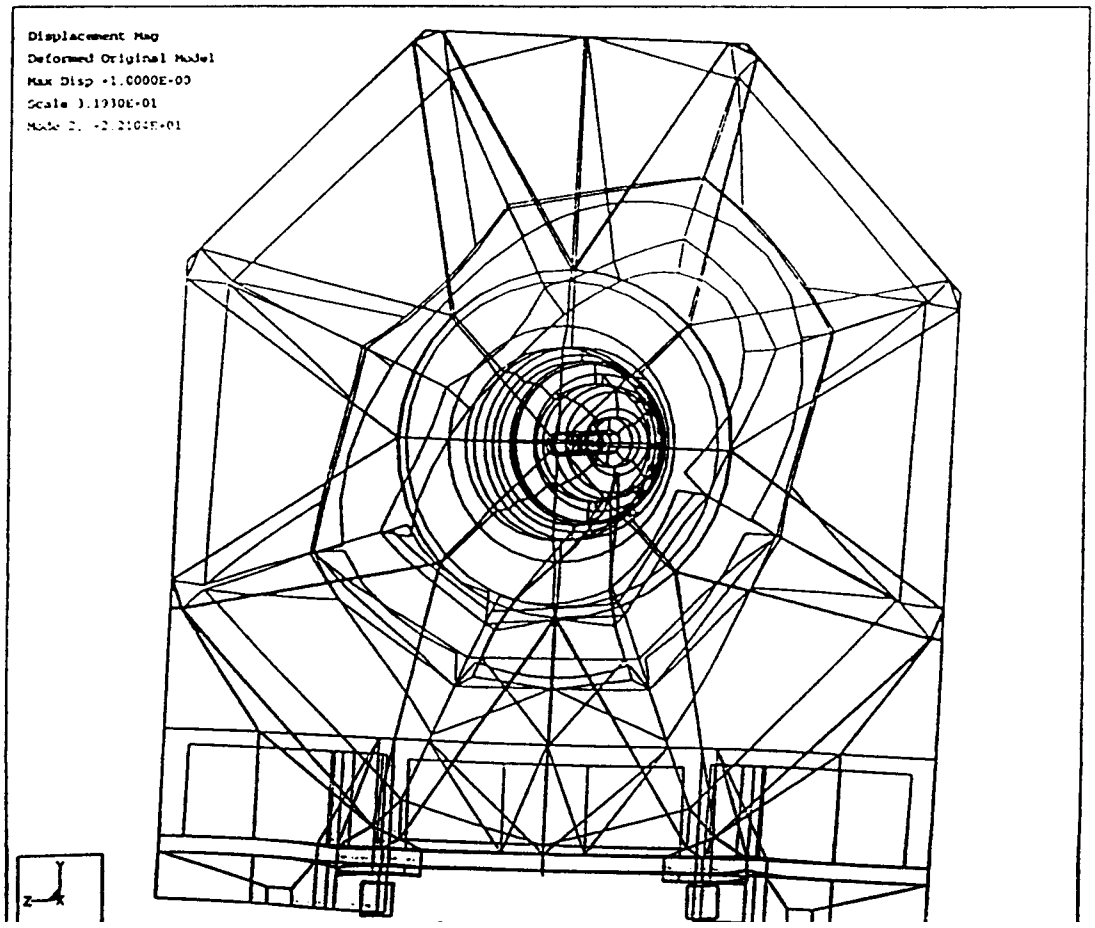


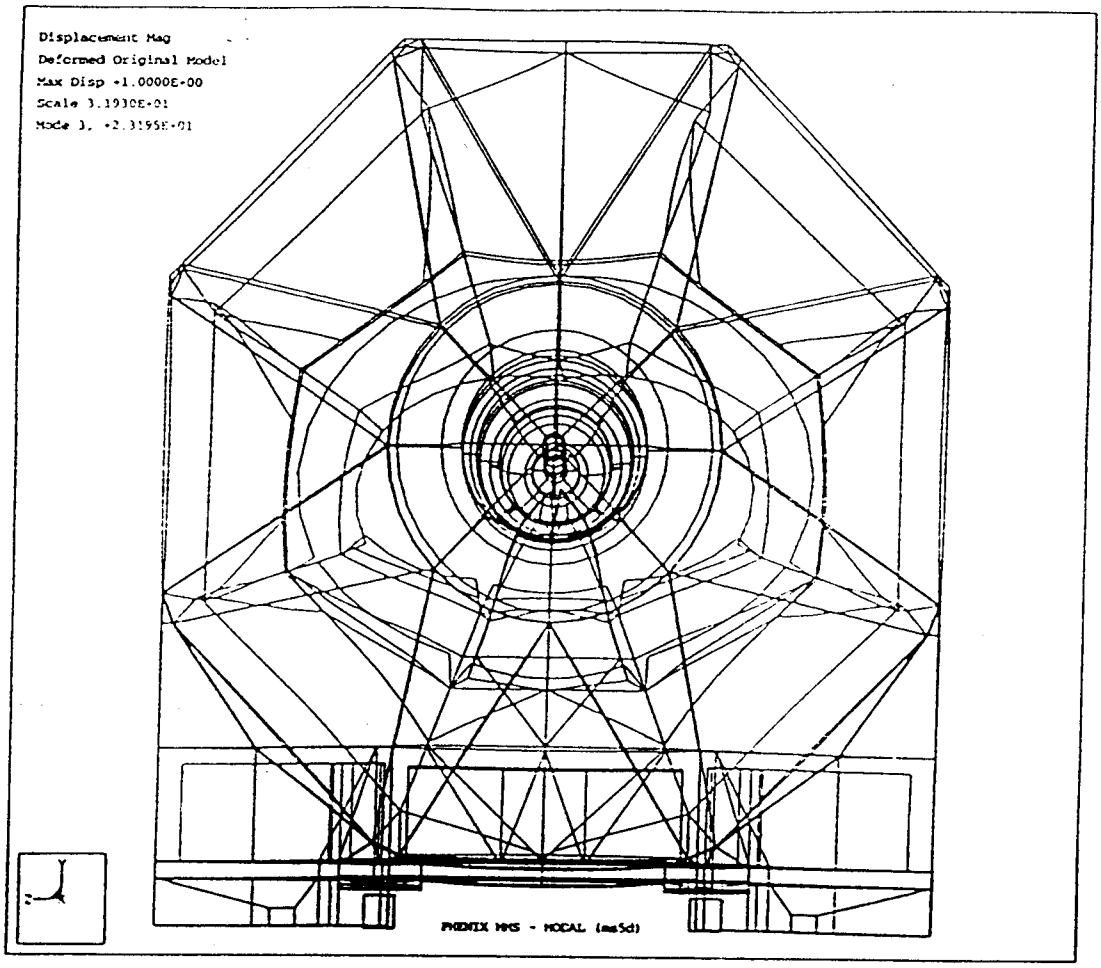
- First mode between 5 Hz - 8 Hz



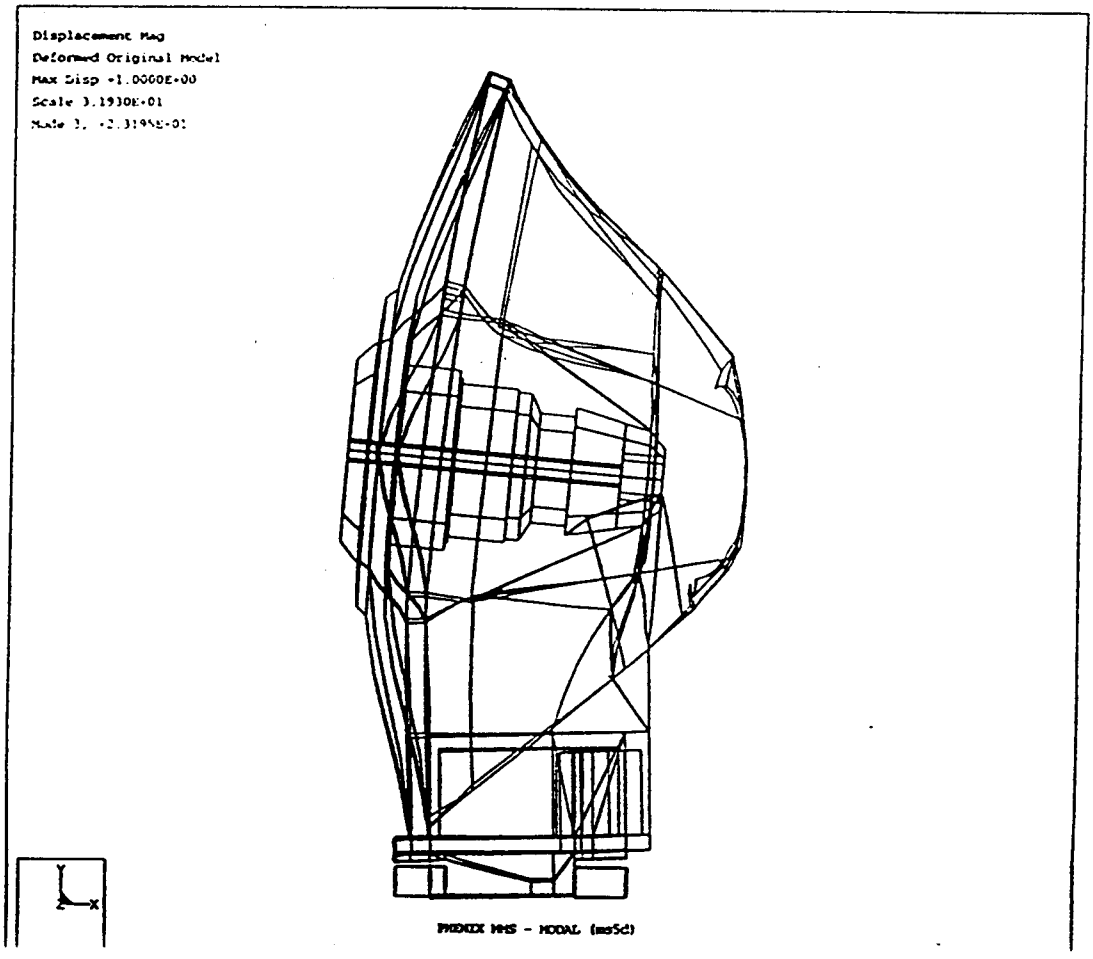


- Second mode 22.1 Hz





- Third mode 23.0 Hz



Finite Element Analysis - Muon Magnet South

Seismic loading

Brookhaven Site Specifications

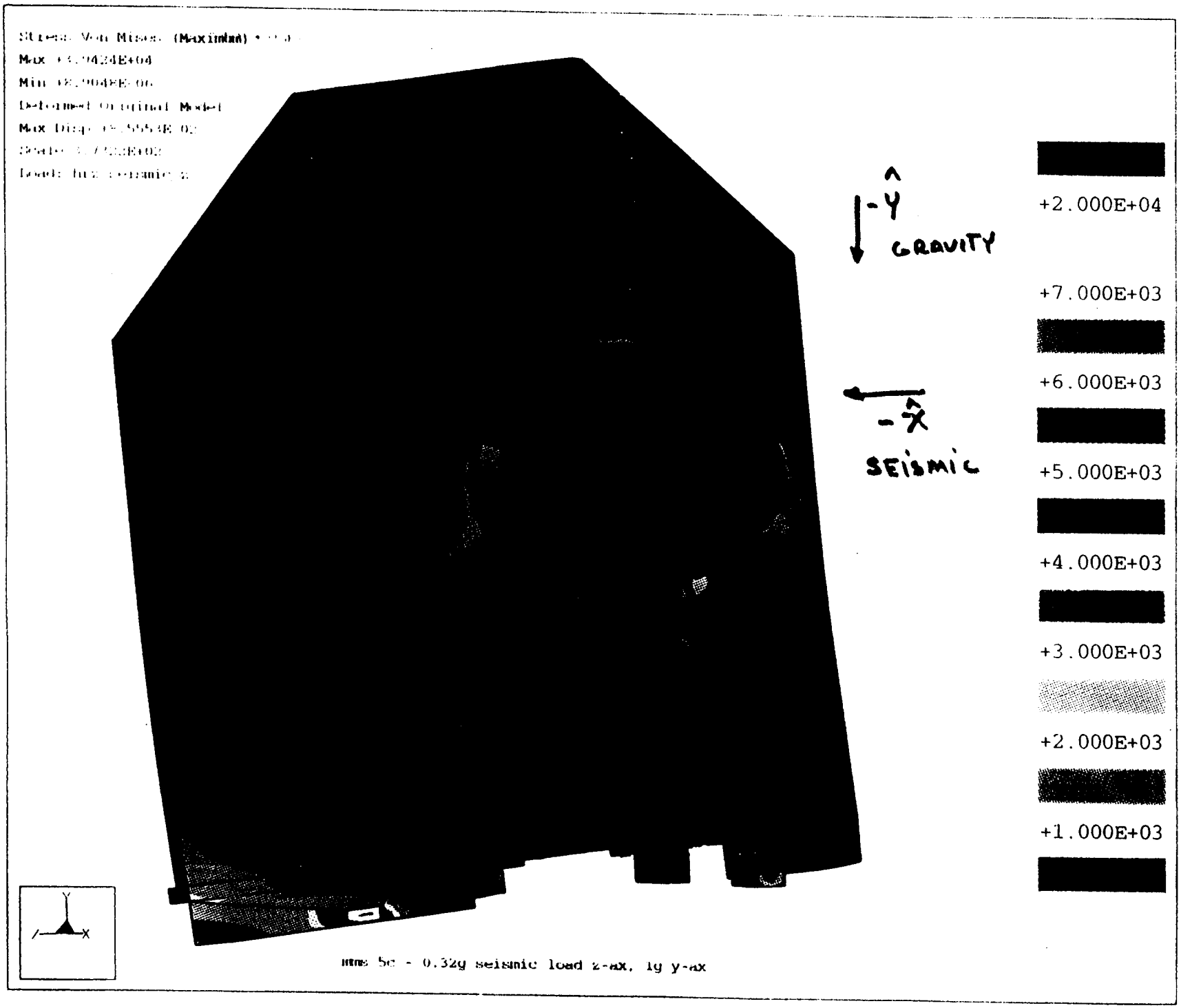
- Vertical 0.15g ground motion
- Horizontal 0.15g ground motion

Response Spectrum for analysis requires peak accelerations.

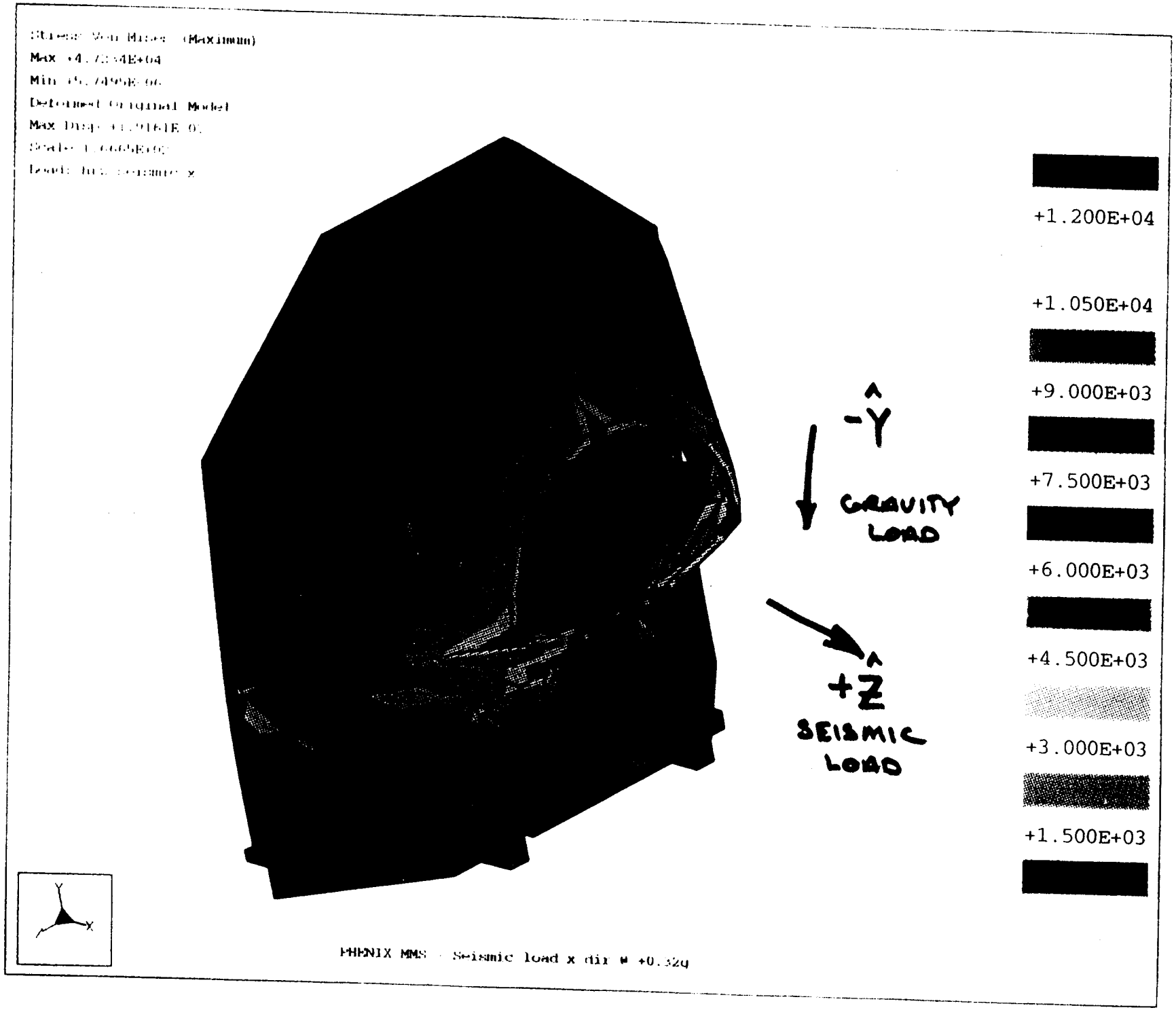
- with 5% damping,
- 0.32g input acceleration for both lateral and vertical

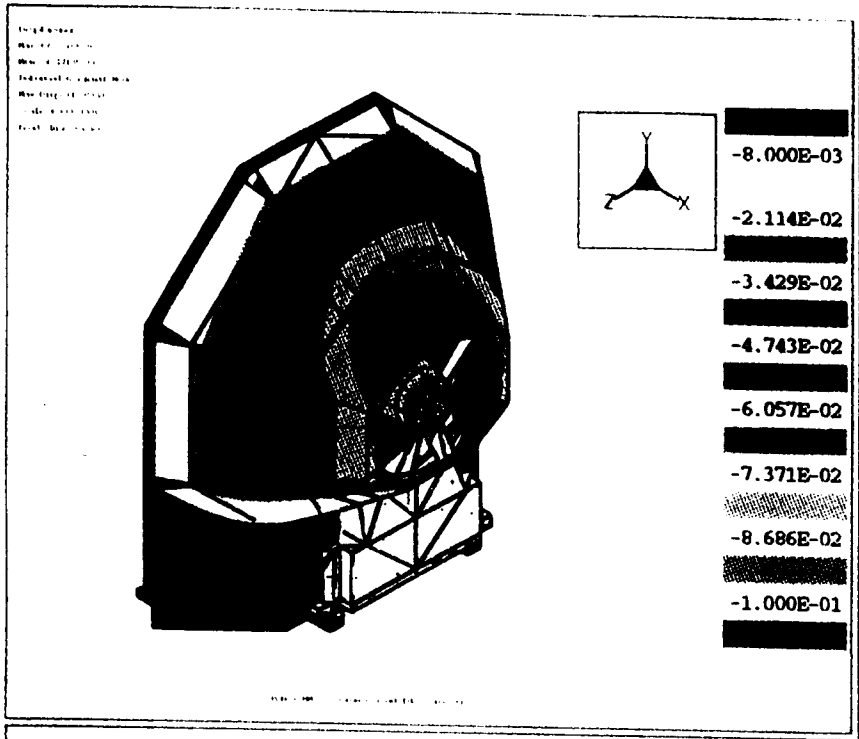
Results

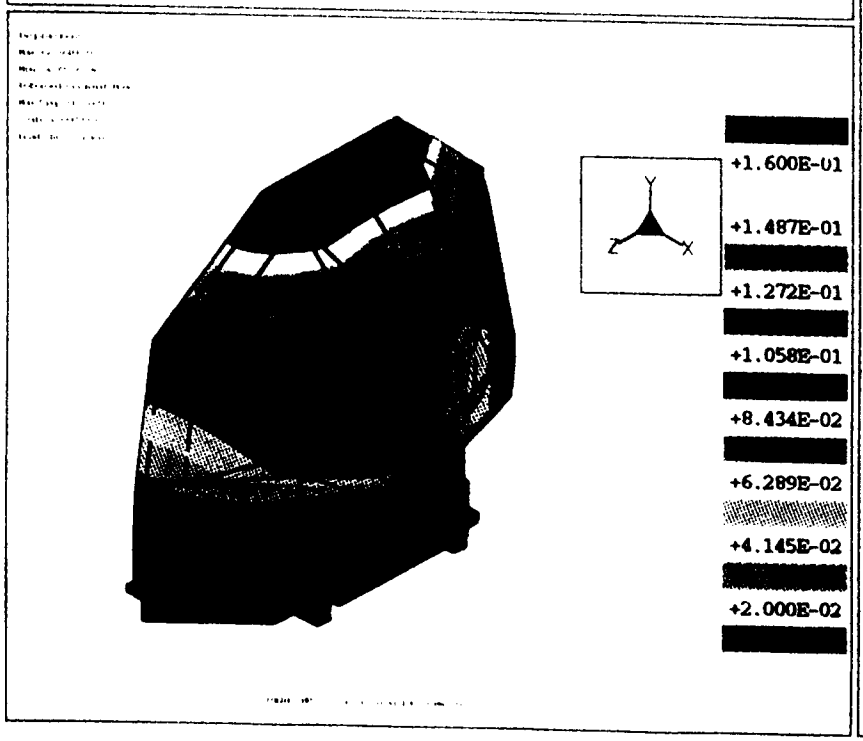
- Displacement magnitudes of 0.19 in.
- Von Mises Stresses on order of 3e+04 lbs/in^2
  (3x static stresses of 1e+04)

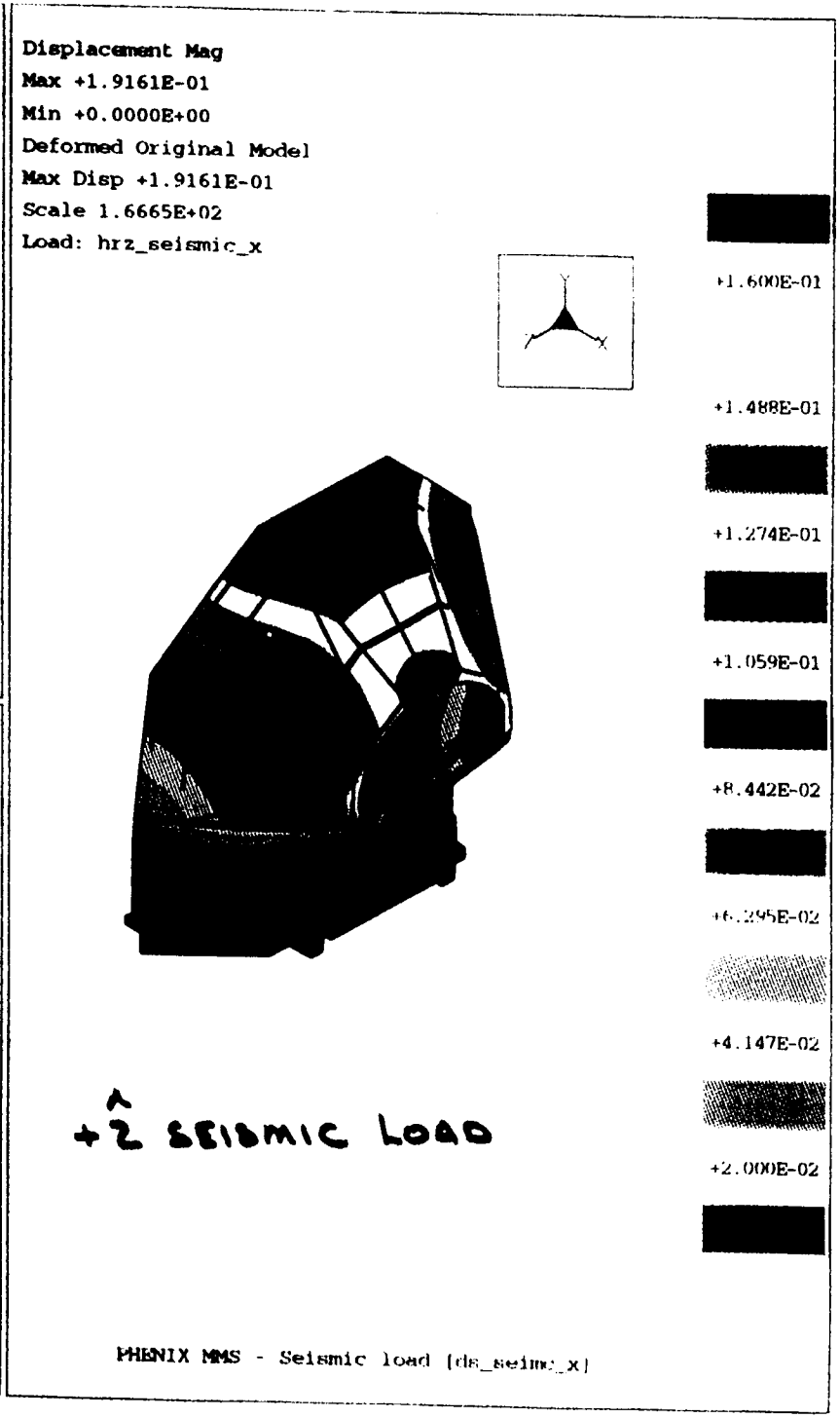


mms 5c - 0.32g seismic load z-ax, 1g y-ax


Stress: Von Mises (Maximum)
Max +4.7[illegible]E+04
Min [illegible]E+00
Deformed Original Model
Max Disp [illegible]E 0
Scale [illegible]E+0
Load: hrs seismic x
+1.200E+04
+1.050E+04
+9.000E+03
+7.500E+03
+6.000E+03
+4.500E+03
+3.000E+03
+1.500E+03
-Y
GRAVITY LOAD
+Z
SEISMIC LOAD
Y
X
PHENIX MMS - Seismic load x dir = +0.32g


-8.000E-03
-2.114E-02
-3.429E-02
-4.743E-02
-6.057E-02
-7.371E-02
-8.686E-02
-1.000E-01


+1.600E-01
+1.487E-01
+1.272E-01
+1.058E-01
+8.434E-02
+6.289E-02
+4.145E-02
+2.000E-02

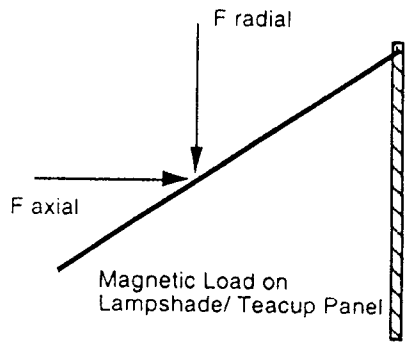

Displacement Mag
Max +1.9161E-01
Min +0.0000E+00
Deformed Original Model
Max Disp +1.9161E-01
Scale 1.6665E+02
Load: hrz_seismic_x
+1.600E-01
+1.488E-01
+1.274E-01
+1.059E-01
+8.442E-02
+6.295E-02
+4.147E-02
+2.000E-02
+2 SEISMIC LOAD
PHENIX MMS - Seismic load (hrz_seismic_x)

Finite Element Analysis - Muon Magnet South

Magnetic loading

Distributed Magnetic Force Loading on single Lampshade/Teacup panel

- Radial Fr = -977 lbf / panel (8.6e-05 psi)
- Axial Fz = 1,853 lbf / panel (1.63e-04 psi)

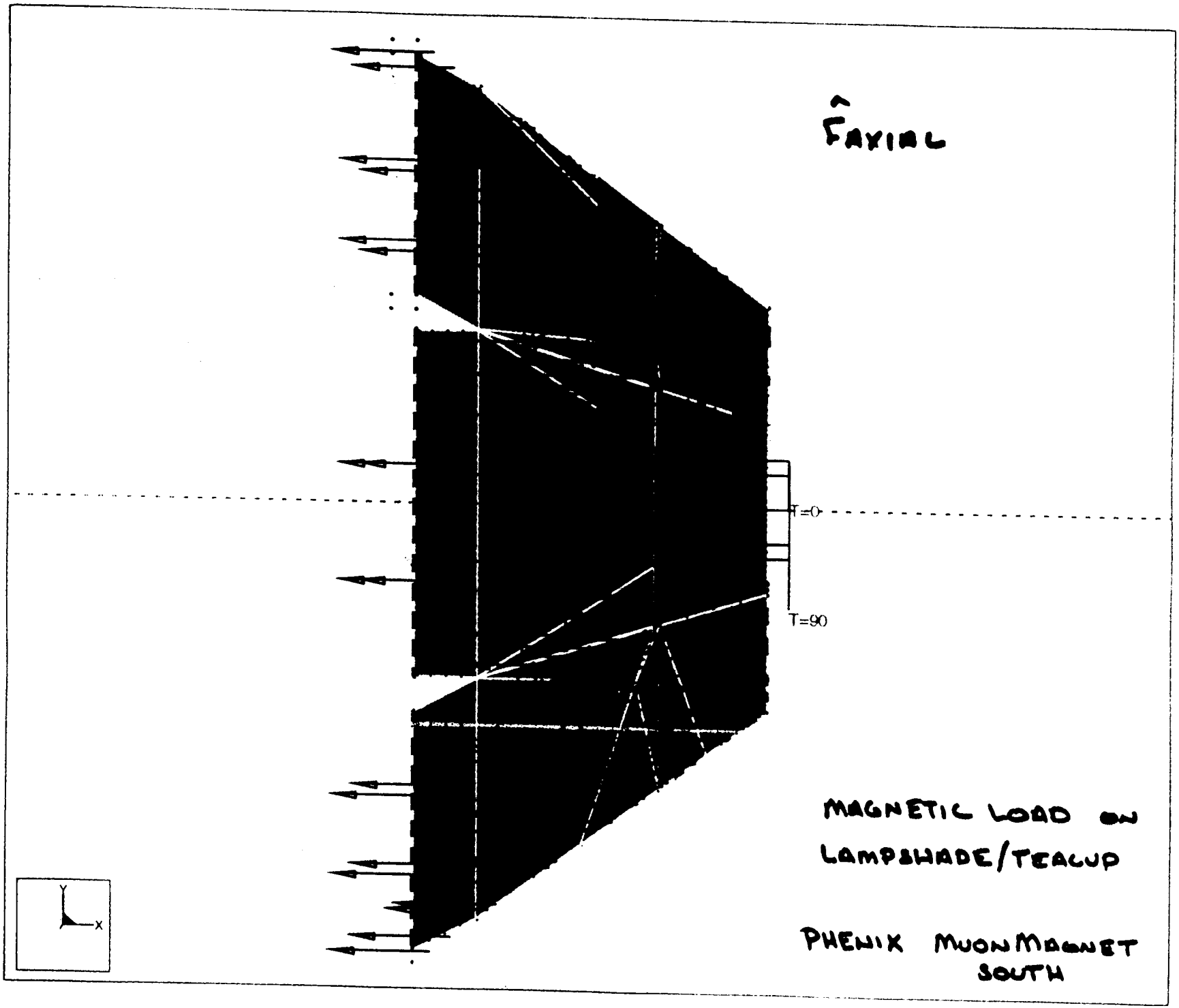


Results

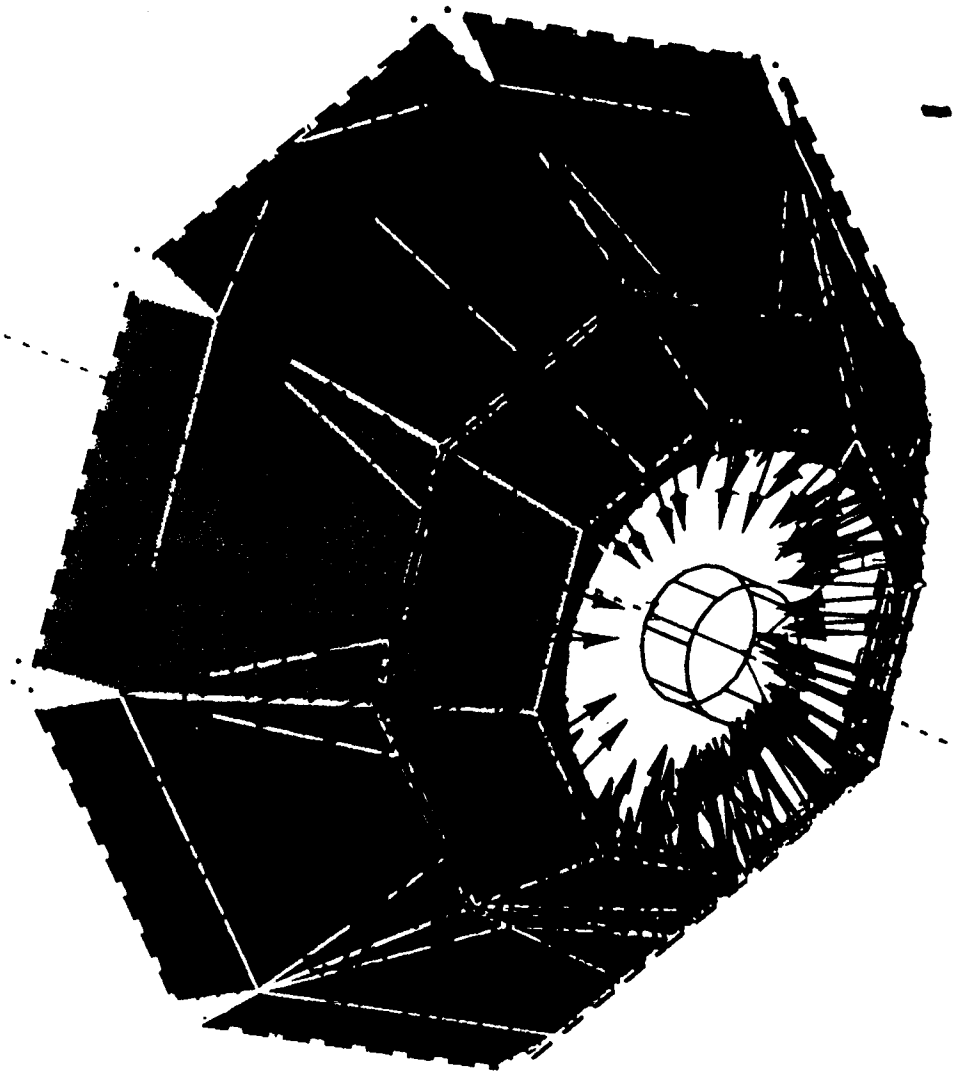
- No significant changes from gravity load conditions
- Radial and axial loading reduced stress

Ambient Ground Vibration

- Analysis is yet to be completed


F̂AXIAL
T=0
T=90
Y
X
MAGNETIC LOAD ON
LAMPSHADE/TEACUP
PHENIX MUON MAGNET
SOUTH

PHENIX MUON MAGNET SOUTH



$-\hat{F}_{RADIAL}$

MAGNETIC LOAD ON TEACUP / LAMPSHADE